PRUNING
Tree and Small Fruits

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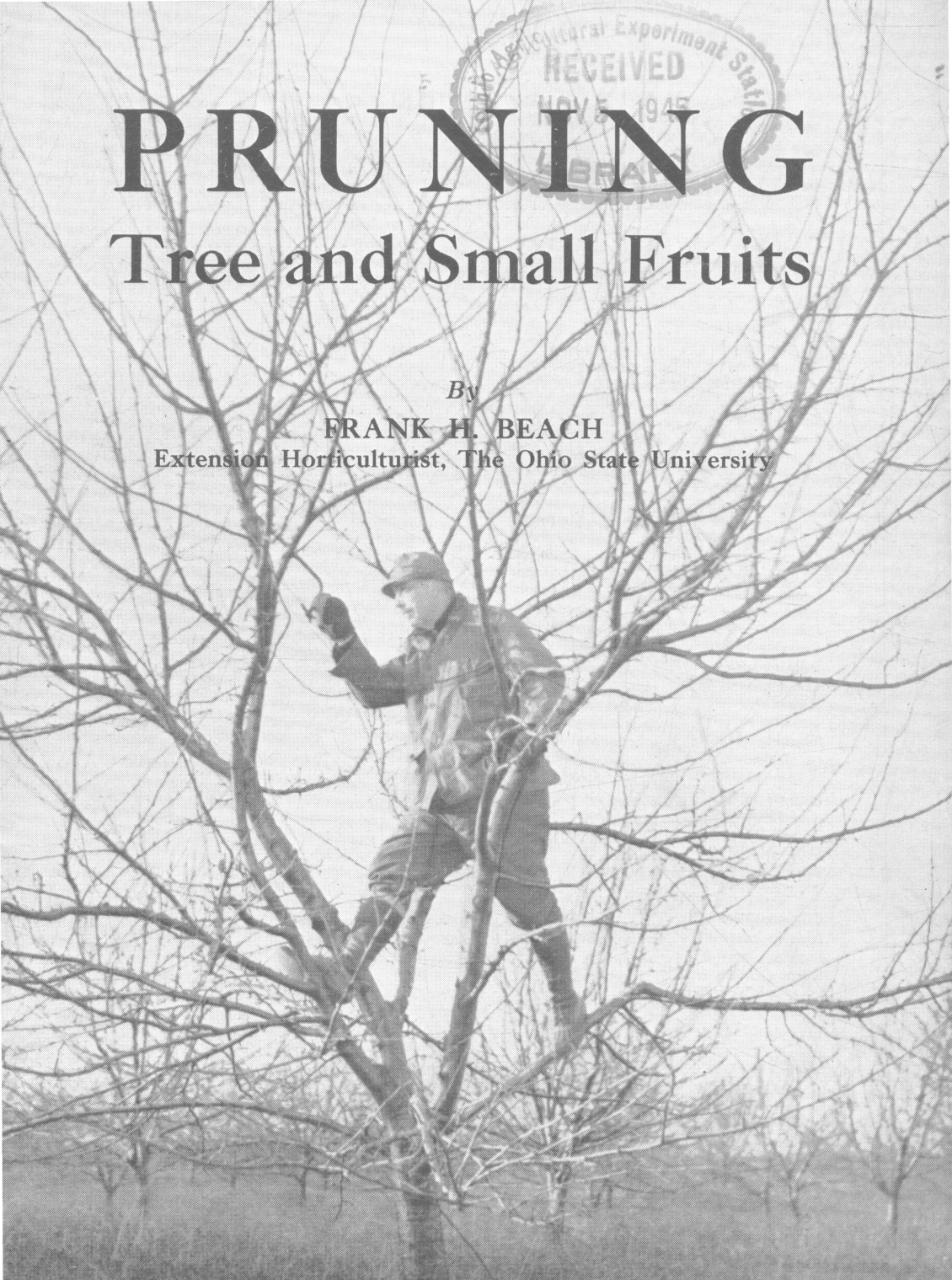

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Pruning Tree and Small Fruits

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Proper pruning will train the tree into a desirable pattern for spraying, thinning, and harvesting. It will develop a strong framework, increase longevity, and reduce loss of wood by breakage. The kind and amount of pruning is determined by the type of fruit, age, variety, existing framework, condition of bark and wood, and the growth and fruiting habit. Heavy pruning dwarfs trees, delays bearing, and is undesirable for young non-bearing trees. The amount of pruning is increased as needed with bearing trees, to remove old or undesirable fruiting wood and to maintain trees in condition for regular bearing and the efficient production of quality fruit.

Fundamental Principles of Pruning

Relation of Growth to Fruitfulness.—There is a relationship between the roots and leaves of plants that must be recognized in order to understand the results from pruning. Materials used by the plant in manufacturing its food supply come from the soil and from the air. The essential mineral nutrients from the soil are received in water solution through the roots. From the air a plant receives carbon and oxygen through the open stomata of the green leaves. In the leaves, these elements combine with hydrogen and water in presence of sunlight to form carbohydrates such as starches and sugars. This process is known as photosynthesis. The mineral nutrients from the soil combine with the carbohydrates to form the proteins and other plant foods used in the growth processes.

If the materials supplied either by the roots or the leaves are insufficient, an unfruitful condition results. An ample supply of stored carbohydrates beyond the requirements for growth is necessary to promote fruit bud formation and to aid in the proper ripening of wood and fruit. It is particularly important that sufficient nitrates and water be available in the early part of the growing season to promote satisfactory growth conditions and fruit setting. An over-supply of available nitrates, which can be induced by excessive pruning, is associated with low-color, starchy fruits on certain varieties, and poorly ripened wood that may be winter injured.

Sufficient branch spacing should be done by pruning to allow a relatively uniform distribution of sunlight on the leaves throughout the tree. The amount of branch spacing by pruning away large limbs and the amount of pruning by distributed small cuts should be coordinated to leave the trees well filled with efficient large diameter fruiting wood. An over-vigorous condition is rather rare and is most apt to be associated with young non-bearing trees. However, an under-vigorous condition is common and exists in nearly all bearing orchards and small fruit plantations.

When fruit plants are growing excessively they are receiving an over-supply of nutrients from the roots, and consequently they need a cultural program

which reduces the intake of mineral nutrients, especially nitrogen. Such plants also need all the carbohydrates they can get through the leaves, and should not have the leaf area seriously reduced by pruning.

When fruit trees or plants are growing weakly, they may have been injured or they are not receiving enough nutrients from the roots. Trees defoliated by insects or diseases, or injured by borers or rodents, need immediate attention to control these pests. Bridge grafting may be needed over wounds.[1] When trees have had their wood injured by winter freezing, the leaf surface will be much reduced. Relatively little pruning, with heavy applications of quickly available nitrogen fertilizer early in the spring, is then needed.

Each kind and variety of fruit has a characteristic amount of growth for a given age and growing location. With young non-bearing plantings, it is desirable to manage them to get as much growth as possible and properly ripen the wood for winter. With bearing plantings, sufficient growth is wanted to maintain desirable new fruiting wood each year. The most desirable amount of growth must be determined by experience, and is discussed as the pruning for the different fruits is described. The orchardist is, therefore, interested in providing for a well balanced supply of carbohydrates, nitrogen, and water for his fruit trees and must prune with this goal in mind.

Movement of Nutrients in Branches.—The various mineral nutrients in water solution are carried up the trunk and branch structures of the tree through vascular tissues which, to a considerable degree, are unit structures as far as each branch is concerned. Therefore, when a large branch is pruned off, much of the vascular tissue which carried water and mineral nutrients into the branch from the root system becomes more or less non-functioning.

On the other hand, when the pruning consists of removing many small branches and twigs from a large branch, with cuts well distributed along the entire branch length, then there is opportunity for a larger dispersal of water and mineral nutrients into the remaining branches, twigs, and fruit spurs. It is desirable that the orchardist understand this physiological process, so that he can prune intelligently.

The movement of plant foods from the leaves is chiefly downward through the vascular tissues of the inner bark to whatever point the food is required for growth and development.

Season for Pruning

Most growers prefer to prune in the dormant season, because other orchard operations are less pressing at this time and branches can be easily seen. Also, pruning is hard work and goes well in cool weather. Trees are not "barked" easily when dormant, and at this time there is least danger of bark pulling away from around pruning wounds. Avoid pruning when wood is frozen.

Wounds usually heal best if the pruning is done just as active growth begins in the spring, and pruning can be best adapted to crop conditions for the year, if done at this time. This is especially true for pruning bearing peach

[1] I. P. Lewis—"Grafting and Budding Fruit Trees," Ohio Agl. Expt. Sta. Bulletin 510, 1932.

trees. But the need of getting the pruning done and the brush removed before spraying season starts makes it necessary to practice dormant season pruning. Winter injury is the great risk with dormant pruning in Ohio. When extremely cold winter temperatures occur, injury is likely to be more serious, if the trees or plants have been pruned in advance of the severe weather. Dormant pruning in November and December is far more hazardous than pruning later in the dormant season.

Mature apple trees and mature trees of other hardy fruits such as pears, sour cherries, and plums should be pruned first. Then in late winter and toward spring, the young trees and the less hardy tree fruits, such as peaches and sweet cherries, can be pruned. Summer pruning is occasionally needed to direct growth with young apple trees, and frequently with young and bearing peach trees. With apples and peaches it is often profitable, when hand thinning during the summer, to do some pruning at the same time to reduce the labor of thinning, and cut away poor fruiting wood which can easily be judged at that season of the year.

Water sprouts are best "mopped off" in early summer, while succulent. The cheapest way to remove them is by hand, using leather gloves. Removal of water sprouts in early summer also helps in aphis control, as this succulent growth is attractive to aphis, and aphis eggs are often carried over winter on water sprouts.

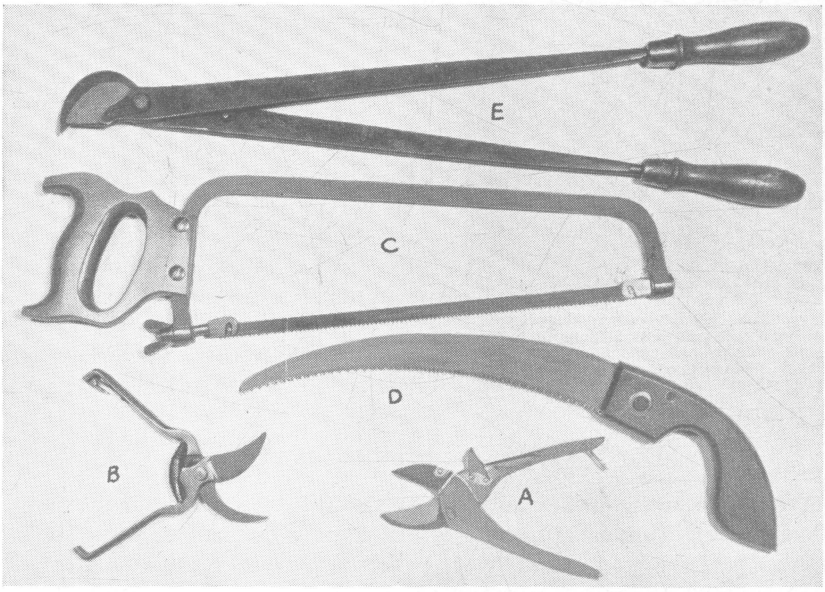

Fig. 1.—Small cuts are made with hand shears. The "roll cut" type hand shears *A* handle small twigs very easily and are very useful for detail pruning. The type hand shears at left, *B*, make snug cuts for all light pruning.

The swivel bladed orchard pruning saw *C* makes a clean close cut in narrow crotches and at difficult angles. The curved saw *D* which cuts on the draw or pull stroke works fast on larger limbs, but does not make as clean a cut; this saw is very rapid in peach pruning.

The steel handled lopping shears *E* are indispensable in peach pruning and useful for mature apple trees where many limbs over an inch in diameter must be cut. Care is needed in placing blade of lopping shears against the supporting limb to make a snug cut.

Making the Cuts

All cuts made with shears or saw should be made with correctly adjusted sharp tools to give a clean smooth cut (see Figs. 1 and 2). In removing a branch, make the cut close, and parallel to the supporting limb. When cutting to a lateral, place the cut so it continues the line of direction of the lateral branch. Stubs do not heal and may start decay.

Fig. 2.—A heavy leather belt supplied with wire hooks on which to hang tools is very handy while working. Swivel bladed orchard pruning saw, hand shears, and lopping shears, are hanging from this belt.

The entire margin of all cuts should be next to active cambium, the layer between the inner bark and the wood of the supporting limb, to promote rapid and uniform healing (see Fig. 3).

In using shears, place the blade against the supporting limb to get a smooth, close cut. With hand shears, if the branch to be removed is bent over the jaw of the shears with one hand while closing the shears with the other, the cut is made with least effort. Never wiggle the shears through a cut, as this makes a ragged wound and may spring the shears. Place cutting blade of shears at the side or below the crotch (but not in the crotch) to secure the best cut.

In removing a heavy limb with a saw, it is often helpful to do it with three cuts. First, make an under cut about 2 inches deep about 8 to 10 inches out from base of the limb. Then cut from above, starting second cut 2 or 3 inches nearer the base of the limb than the under cut. Thus, the limb will fall off without tearing down bark into the supporting limb. The short stub can then be removed with a close cut made against the supporting limb.

Dressing Pruning Wounds and Cankers

Wounds under 2 inches in diameter seldom require wound dressings. A wound dressing should be used for larger wounds on main branches or trunk of apple, pear, plum, and cherry trees. There are several good wound dressings, such as asphalt tree paint, grafting wax, and shellac. A satisfactory cheap antiseptic paint can be prepared by mixing powdered Bordeaux spray material with raw linseed oil to the consistency of thick paint, and applied while fresh.

Do not cover a growing callus with wound dressings, as this retards the growth of callus over the wound. Apply wound dressings to exposed wood only.

Where dead areas of bark or large disease cankers are found on large limbs and trunk, trim away dead and injured bark back to live cambium, pointing the wound at the upper and lower ends wherever possible.

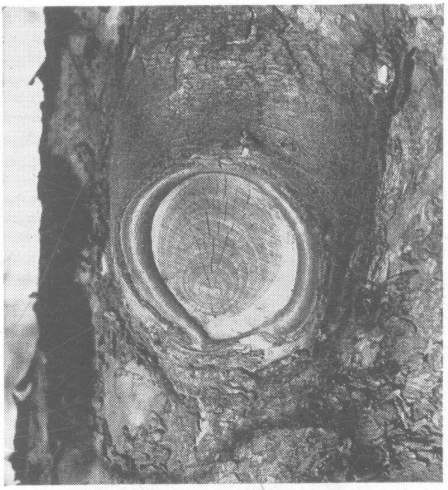

Fig. 3.—A close pruning cut which is healing satisfactorily.

To promote rapid healing of the wound, leave bark at edge of wound with a vertical cut to the sapwood and not a sloping cut. The latter retards healing. Diseased areas are best trimmed and treated in the dormant season to prevent spreading the disease with tools. Special injuries such as winter injury in framework crotches and on trunks, rabbit and mouse girdling require prompt treatment and, where bridge grafting is needed, the work should be done in early spring as growth starts. For large wounds and where girdling has occurred, a bridge graft for every 2 to 3 inches of lateral injury is recommended.

Where cankers of diseases such as fire blight, bitter rot, and black rot are present, it is desirable to cut away all dead branches, and remove limbs which have been more than two-thirds girdled by any sort of canker. Diseases such as black rot, "frog eye," and bitter rot of apples are often spread from dead twigs and branches. It is important to keep dead wood removed with annual pruning, if possible.

Fire blight is the most common canker on apples and pears, and these need not be cut if the following solution is used to cover them:

Fire Blight Canker Solution. To 4 tablespoons of concentrated hydrochloric acid add 1 quart of hot water in an enamel kettle, and in this mixture dissolve 9 pounds of dry zinc chloride powder. Commercial grades of chemicals are satisfactory for this solution and can be secured from a local drug store. Add sufficient red or blue coloring, using any good dye, so that areas treated can be checked for thorough work. After cooling, pour above solution into 7 pints of denatured alcohol and mix well. Store in tightly stoppered large glass bottles or jugs to prevent evaporation. Apply with small paint brush.

Types of Pruning

The growth response from pruning is almost entirely localized in the immediate vicinity of the cut. Shoot growth following pruning is greatest near the cuts, and small branches and spurs in the vicinity are invigorated. The growth and fruiting habit on branches not pruned are affected but little by pruning cuts elsewhere.

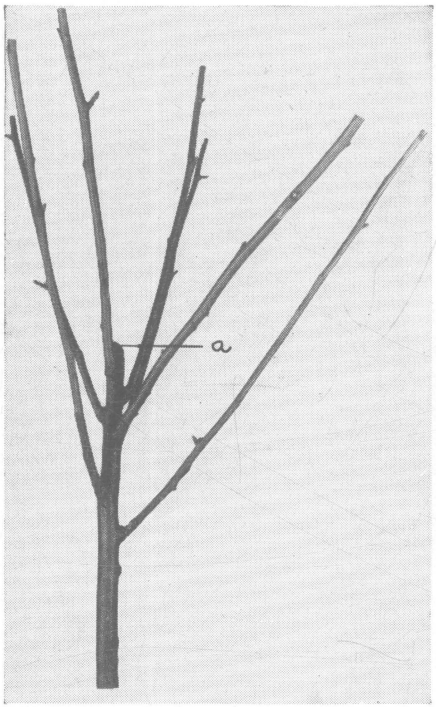

Fig. 4.—Result of a heading-back cut at *a* which forced buds just below the cut into vegetative branches. Such cuts develop thick trees with much unproductive wood.

Heading-Back Pruning.—When a terminal growth is left without any cutting, it normally continues its main growth from the terminal bud. If it is cut back or "headed back," however, several buds immediately below the cut are forced into active growth, and develop into a number of vigorous and competing branches (see Fig. 4).

Such pruning multiplies the number of terminal growths and discourages the normal development of lateral branches, twigs, and fruit spurs below the cut. If carried to extremes on young non-bearing trees, this method of pruning results in dense growth, with a preponderance of strongly vegetative wood which retards bearing. Too many young trees have been dwarfed and kept out of bearing by "all-over" heading-back pruning.

Heading-back cutting is of value in pruning the young trees to enable the grower to start the head where he desires. It is also of value on the trees that have made a very vigorous and leggy terminal growth, to secure a desirable placement of the lateral branches.

When terminal growths are headed back, the cluster of shoots arising just below the cut often provides more branches than can be used at a given place (see Fig. 4). This means that the next time the tree is pruned, many of these shoots must be removed or the tree will become too dense. Considerable heading-back pruning, therefore, is undesirable, because it calls for too much thinning-out pruning later. This heavy pruning seriously dwarfs the tree, because of the large leaf area removed in the prunings.

Thinning-Out and Bulk Pruning.—Where branches are pruned away entirely, it is termed "thinning-out pruning." When confined to the removal of rather large limbs, it is called "bulk pruning." Most pruning is of a thinning-out type, to prevent trees from becoming too dense, to make corrective cuts, to improve framework, and to remove "thin" unproductive branches which will no longer produce desirable fruit.

Thin Wood Pruning.—When pruning cuts remove slow growing, underhanging, fruited-out branches, it is termed "thin wood pruning." The term "thin wood" was first used by Michigan Agricultural Experiment Station workers, who arbitrarily classified it as 4-year apple wood less than 2/8 inch

in diameter at the base at the fourth year annual "ring." They also classified 4-year wood as "intermediate" if more than 2/8 inch and less than 3/8 inch in diameter, and "thick" or productive with a diameter of over 3/8 inch at the base. They found that thick apple branches produced at least ten times the quantity of desirable apples that thin wood branches produced. There is probably considerable variation in the kind of thin wood that can be tolerated by variety, location, and other environmental conditions.

"Thin wood" is best observed by standing near the trunk and looking out and up at harvest time. Observe the location and growth habits of limbs and fruiting branches producing inferior fruit. Also, locate the unproductive branches. A few harvest-time notes on each variety and age group of trees will help you plan the next pruning to remove the poorest fruiting wood, and leave the best in sufficient quantity with the least labor expenditure.

Thin wood appears first on the oldest low branches of bearing trees and in the inner areas of the trees. A good pruning procedure is, first, remove any larger limbs whose fruiting wood is mostly of the "thin wood" type. Then slender, underhanging, thin wood branches can be removed from the more desirable lower limbs. Finally, the upper and outer areas of the trees can be gone over to remove any undesirable thin wood. As trees get older, pruning has to be more of an all-over nature, according to annual needs. It is important that the brush pile consist mostly of fruited-out, thin wood, and branches poorly located to produce satisfactory fruit.

Fig. 5.—Height of this apple tree is controlled by cutting back tall branches in the top to strong outward growing laterals to keep the tree about 20 feet high. Some branches that droop to the ground with fruit have been removed to an upward growing lateral as the arrows indicate.

Cutting to Lateral Branches.—Lowering or shortening a limb by cutting to a lateral branch (Figs. 5, 6) does not induce as many side branches as a heading-back cut (Fig. 4). Also, it does not dwarf the branch as much, particularly if the lateral is a strong growthy branch of about the same size as the main branch. As a result, cuts to laterals can often shape or direct the growth of a tree where a lower, shorter, or more open type of growth is desired.

This kind of pruning is employed to lower the tops of tall trees and to keep trees within easy economical range for spraying, thinning, and harvesting. Branches that droop to the ground or those which overgrow other limbs are often cut back to an upward growing lateral, preferably placing the cut on the under side of the main branch. Peach growers cut to outward laterals to hold trees at proper height and to keep the tops sufficiently open and spreading.

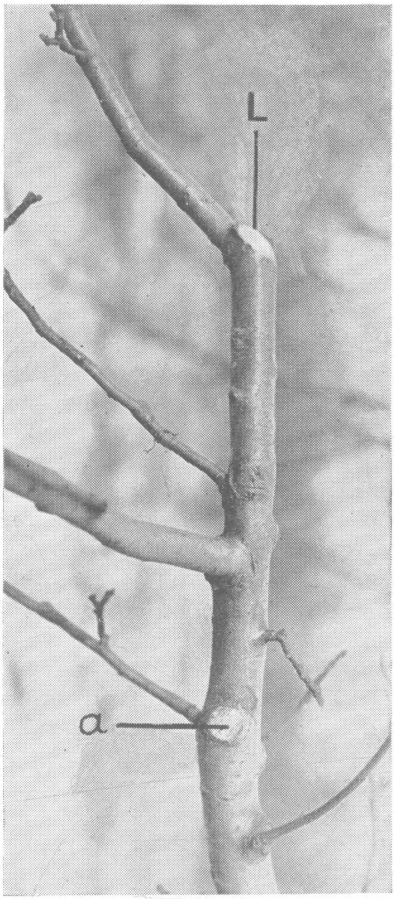

Fig. 6.—Cutting to a strong lateral, as at *L*, is the most desirable method of shortening a limb. The cut at *a* where a side branch has been removed is properly made.

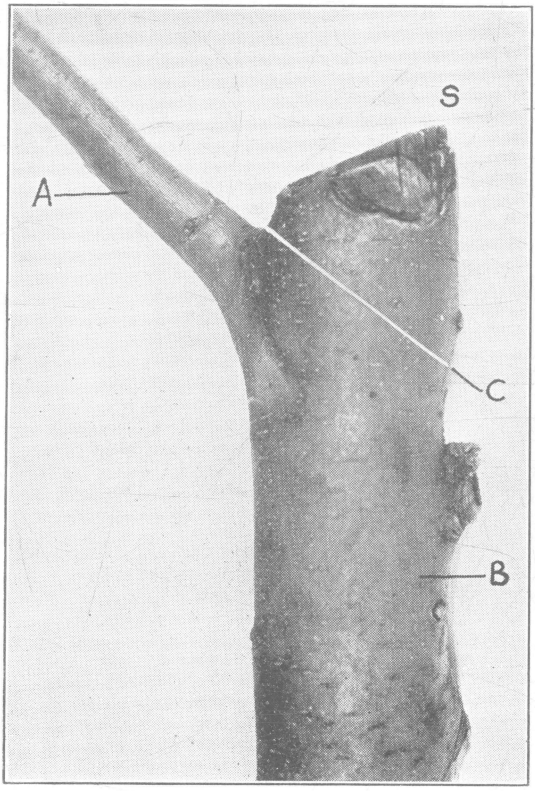

Fig. 7.—This cut to a lateral was improperly made. Lateral *A* is too small a limb at which to place cut. Compare with size of lateral used in Fig. 6. The cut across main limb *B* should have been on line *C* to permit healing of wound. Note high stub *S* is dying back because it is above active cambium in limb *A*—*B*. (*Ohio Exp. Sta.*)

In making a heading-back cut to a lateral, the cut should follow the direction of the lateral so that the wound will heal to the best advantage (see Figs. 6 and 7).

Detail Pruning.—Where cuts are confined to removal of small branches, not necessarily thin wood, distributed over a long length of limb, it is called "detail pruning." Detail pruning improves size and color, similar to hand thinning of the fruit and with less labor expenditure. It is often employed to advantage on fruits and varieties that tend to overload and produce small sized fruit such as Transparent, Wealthy, Golden Delicious, Rome, and Jonathan apples and most varieties of peaches.

Correction of Weak Crotches.—When two branches arise at the same place on young trees and are about the same size, they will form eventually a weak crotch which may split (see Fig. 8). The most desirable method of handling a weak crotch is to cut off the poorer branch. If a lateral is wanted where one of the forks arises and the crotch is not weak, cut one limb back heavily. This will dwarf it into a lateral.

Encourage framework branches that leave the trunk at a wide angle, approaching 90 degrees, as shown at the left in Fig. 9. These will develop strong shoulders at their union with the trunk.

Poor crotches, that could have been improved by correct pruning at the right time, cause heavy loss to orchardists.

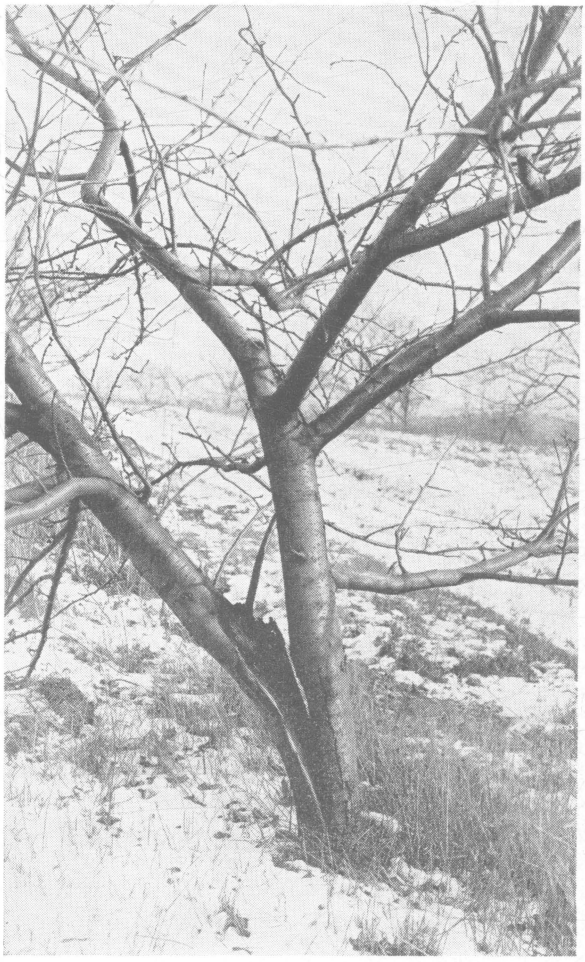

Fig. 8.—The result of allowing a weak fork at the head to remain uncorrected. If the left limb of the fork had been removed or cut back heavily to a lateral when the tree was young this weakness would have been corrected.

Pruning as Related to Growth and Production of Young Trees

Pruning has a dwarfing effect upon young trees. This has been clearly shown by the Ohio Agricultural Experiment Station and by the experiences of fruit growers everywhere All leaves contribute food for growth of the trees, and any pruning reduces this leaf surface While terminal growths near the cuts may be heavier after pruning a young tree, the total growth of all terminals of the pruned tree is less than if it were not pruned With young trees, pruning should be only heavy enough to accomplish necessary training purposes Every unnecessary cut is an economic loss.

At the Ohio Agricultural Experiment Station, heavily pruned trees were smaller for age and did not come into bearing as early as unpruned or lightly

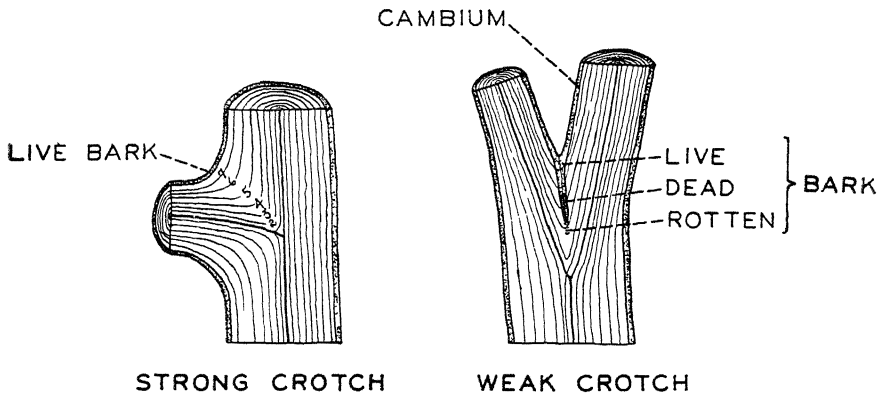

Fig 9 —*Wide crotch angles insure strength* The angle of the crotch on the left is wide Note relative thickness of the seven successive layers of wood (numbered) laid down by the cambium in this crotch angle

The angle of the crotch on the right is narrow Observe that the bark of each branch in the crotch angle comes together before the crotch is filled with woody tissue Annual layers of wood in the crotch are relatively narrow A cleavage line results from the bark inclusions in the narrow crotch Note that live bark dead bark and rotten bark are found in succession down the cleavage line of the crotch, which prevents union and encourages decay A narrow crotch is weak splits down with overloads and is often associated with winter injury on adjacent bark

Use scaffold branches that leave the trunk with a wide angle

pruned trees Unpruned trees, while largest, were ungainly and had many framework defects Lightly pruned trees, properly trained, were best. During the first 17 years after planting, light pruning reduced the yield of Baldwin 26 per cent, and heavy pruning reduced the yield 31 per cent, as compared with unpruned trees With Stayman, light pruning increased yield by 11 per cent, while heavy pruning reduced yield by 28 per cent as compared with unpruned trees. This further shows the need of adapting the pruning program to suit the variety.

Pruning as Related to Fillers and Planting Distance

Filler trees are those trees which are planted between the permanent ones to increase the production of fruit before the permanent trees fully utilize the

ground. Such trees are given practically no pruning to develop desirable framework. As the fillers begin to crowd, heavy cutting back of side branches is done on them, so that the permanent trees develop symmetrically without the slightest crowding at any time. Heading-back pruning is increased in severity on the fillers, flattening or "fanning" them until such time as the permanent trees need all the room. Then the fillers should be removed.

When fillers are headed back severely, it is often desirable to ring[2] the trunk late in May each year. This concentrates stored plant food above the ring, encouraging blossom bud formation, and improves yields and quality on the smaller topped trees.

Fig. 10.—Filler row of Wealthy heavily pruned by "fanning" to prevent interference with permanent trees. Fillers will soon be removed.

A combination of heavy heading-back of all important branches on fillers, with annual ringing of the trunk to keep the heavily pruned tree fruitful, has considerable merit in handling filler trees. The fruit produced is especially large and well colored. It definitely keeps filler trees from crowding the symmetrical development of the permanent trees.

When the permanent trees need all of the room, it is not such a mental hazard to remove a butchered filler tree as it is to take it out in its prime, when it looks about like the permanent tree. Many filler trees have been successfully handled over a period of 8 to 10 fruiting years with successive annual trunk ringing, and heavy heading-back pruning.

[2] Gourley, J. H. and Howlett, F. S.—"Ringing Applied to the Commercial Orchard"—Ohio Agl. Exp. Sta. Bulletin 410, 1927.

Fig. 11.—Apple tree given heavy pruning in late fall of 1935. Seriously injured by the low temperatures of the severe winter of 1935-36. This was the only tree lost in the block and the only one given fall pruning ahead of the low temperatures of early winter.

PRUNING THE APPLE TREE

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Nursery Stock

In buying apple trees from the nursery, insist on well grown trees, true to name, free from disease and insect injury, and preferably with 1- and not more than 2-year-old tops. One-year-old trees, of large diameter and a height of 4 to 5 feet or more, transplant best. Well branched 2-year-old trees of about ¾ inch diameter, tops from 5 to 7 feet are satisfactory. Avoid trees that are undersized, crooked, or with short, slender growth. Plant in the fall or early spring.

If trees have dried in shipment, soak in water for a day or two before planting. If planting has to be deferred, dig a trench running east and west, break the bundles, loosen and spread the trees, place the tops to the north, and heel-in well to keep the roots moist.

The roots have been shortened in digging and handling, so no more pruning of roots is needed except to remove broken roots and ragged ends. Top pruning at planting time, as described below, is needed to compensate for this root injury. Plant about 2 inches deeper than tree stood in the nursery. With branched trees, place best lower limb toward prevailing wind (usually southwest) and lean the tree slightly in that direction. Place top soil about each root and firm soil well as hole is filled.

Training Young Apple Trees

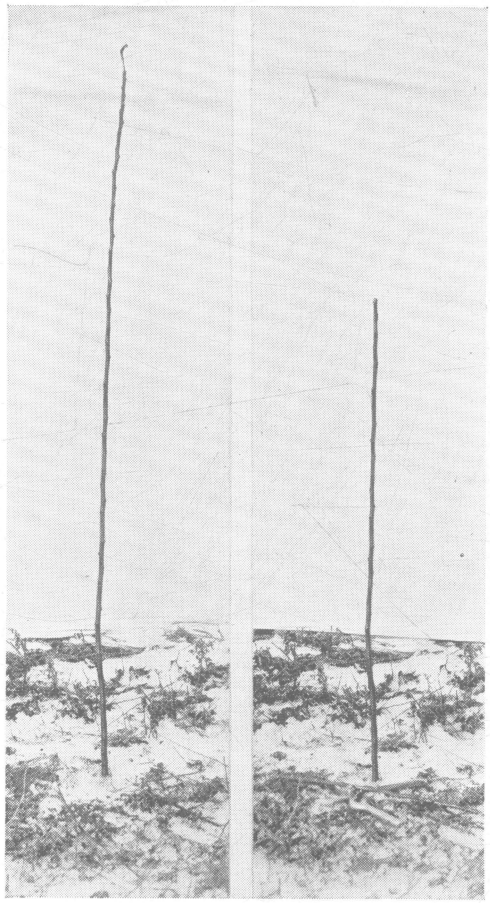
Pruning 1-Year Trees at Planting.—Where well grown whips over 4 feet tall are planted, the top is cut off about 50 inches above the ground after planting. In early summer, after the tree is well started and lateral branches can be observed, head back again just above the highest desirable lateral which makes a wide angle with the trunk. The following spring select three additional side branches, if available, that leave the trunk at a wide angle, well spaced vertically, and around the tree. The lowest branch, if possible, should be about 18 inches above the ground and on the southwest side of the tree.

Yearling whips less than 4 feet in height are less desirable than the taller trees, but it is often necessary to use them. Good trees can be started by heading them back to about 30 inches at planting time, cutting back again as described above to the highest desirable lateral. As this develops into a limb which continues as the trunk, additional scaffolds can be taken from it during the second and third year, or as they become available.

Pruning 2-Year Trees at Planting.—Two-year-old trees have been headed in the nursery, and come as branched trees. A tree usually will have several branches arising very close together near the point where the tree was headed. Two or more of the branches may be already competing as leaders. Select the best branch for a leader and cut it back as suggested above for 1-year-old whips.

When planting, place the lowest desirable scaffold branch on the southwest side (see Fig. 13). It is desirable for this branch to be at a height of about 18 inches, forming a wide angle with the trunk. Cut this back to about one-third.

A start may also be made at selecting higher scaffolds, provided a vertical distance of 8 to 12 inches can be secured between limbs.



(*a*) (*b*)

Fig. 12.—(*a*) One-year-old apple tree as it comes from the nursery before pruning. (*b*) Same tree after pruning; top has been cut back to 30 inches.

Prune away all branches that form narrow angles or are too close to be desirable for scaffolds. It may be necessary to leave only one lateral scaffold after the pruning. Additional scaffolds, properly spaced, will arise from the leader. The vertical distance between the centers of limbs does not increase with age, but as the limbs increase in circumference they appear to grow closer together. This is sufficient reason for wide spacing of scaffolds on young trees. The heading of young trees is a gradual process, and may require 2 or 3 years or more to establish a satisfactory head with sufficient vertical and radial spacing between scaffolds.

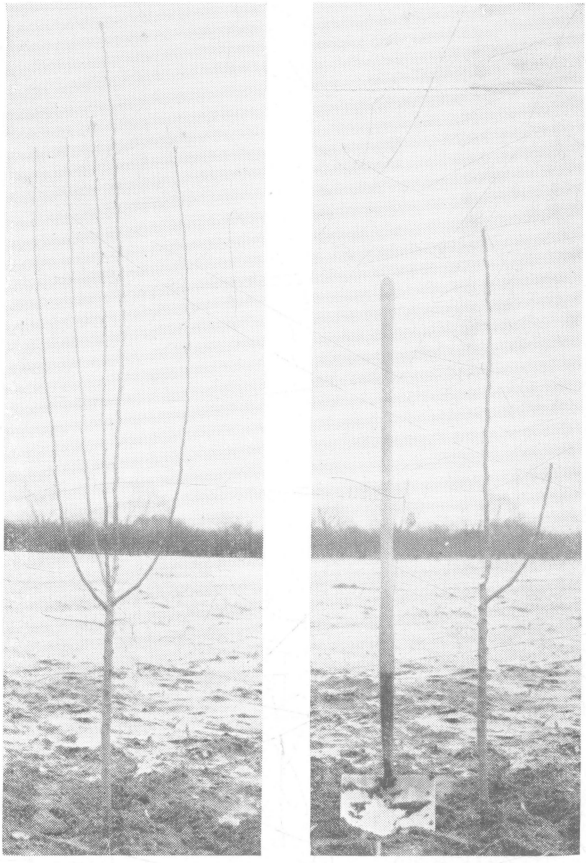


Fig. 13.—Two-year-old apple before and after pruning at planting time. Largest best central branch has been retained for the leader and cut back to about 50 inches. Tree was planted with best wide angled lateral to the southwest, which was cut back two-thirds. All other laterals were removed because they arise too close together.

Pruning After 1-Year Growth in the Orchard.—Select the strongest upper branch for a leader around which to space the lateral scaffolds. It is important that any branches leaving the trunk at a narrow angle be removed to avoid weak crotches in the framework. Whorls, double and multiple leaders must be eliminated.

As they become available, select three or four well placed scaffolds around the leader and cut away competing branches.

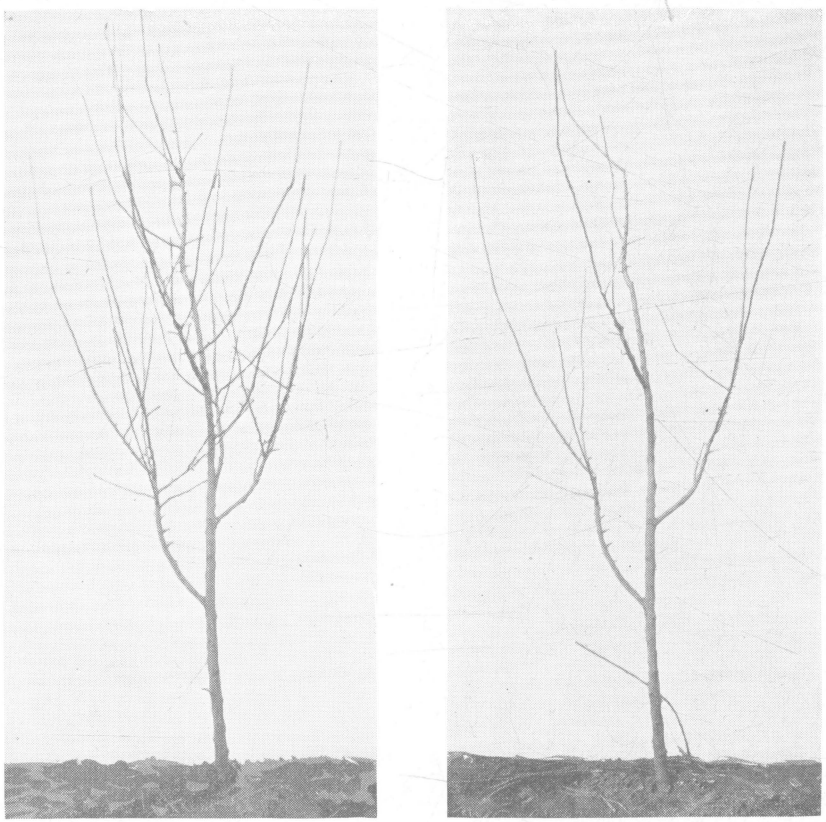
No heading back of the leader or laterals is advisable unless growth is very long and unbranched, say in excess of 30 inches.

The trees should be gone over at least every spring to remove water sprouts and surplus branches competing with desirable scaffolds, and to be sure that no scaffolds are allowed to grow which form a sharp angle with the trunk. Very little pruning need be done on the secondary branches that arise from the scaffolds. In this way pruning can be kept light and still accomplish the purpose of training, and at the same time encourage early heavy bearing.

The Modified Leader Tree.—The modified leader tree is preferred for training apples, pears, plums, and cherries; a modification of it is coming into use with peach trees. It consists of a central trunk around which scaffold branches, of the desired number and spacing, can be arranged. It is desirable to limit the number of main scaffold branches to about eight in most mature apple trees. Weak crotches and crowded scaffold branches are eliminated.

After about four lateral scaffolds have developed, the leader is "modified" by cutting to an outward growing lateral, or by cutting enough branches off the side of the leader toward the prevailing wind so that a drooping away from the wind is secured (see Fig. 14-b). This training, assisted by early fruiting, pulls the leader out of the center of the tree into a side branch. This method of modifying the leader is commonly practiced with apples.

The purpose of a trunk is to provide a central framework around which desirable scaffold branches can be arranged. As soon as a sufficient number of desirable scaffolds have been secured there is no further need for a trunk, and at this point it is modified by encouraging it to develop into an upper



(*a*) (*b*)

Fig. 14.—(*a*) Golden Delicious apple tree planted as a whip, then allowed to grow 2 years in the orchard before pruning. (*b*) Same tree after pruning. Four lateral scaffolds with 8 inches or more vertical spacing have been selected and leader modified by cutting to outward lateral.

outward growing scaffold. Secondary branches from the scaffolds will build the tree to a desirable height and spread, and, as trees begin to bear, the weight of fruit will open and spread the trees in a normal, satisfactory way. If young trees are opened and spread by excessive pruning, the trees will be too open and out of balance when the weight of cropping pulls the branches farther apart and downward.

With peach or sour cherry the leader is modified by cutting to an outward lateral at a height of about 4 feet, while with apples it is often carried higher, to from 5 to 8 feet, then if it does not divide naturally into a desirable outward branching system, it is modified by pruning. A sufficient number of scaffolds usually can be selected by the time apple trees are 4 or 5 years old.

Subsequent Pruning of Young Apple Trees.—The orchard must be gone over annually for light, corrective pruning and to continue proper training. *Keep the pruning light, and, if in doubt about a cut, do not cut.* Leave small branches and spurs throughout the tree as long as they bear fruit of satisfactory quality.

A few suggestions are given, but nothing will substitute for common-sense judgment in determining the cuts for each tree.

1. Remove any dead, cankered, broken, or badly diseased limbs.

2. Remove as soon as observed (if they can be spared) branches which leave the leader at a narrow angle. These branches will make weak crotches, and are not desirable for permanent limbs. Small branches, which are not competitive with the desirable development of the main scaffold limbs, can be left as long as the fruit produced by them is satisfactory.

3. On young trees that have not had proper training from planting time, scaffold branches may cross each other. Where this occurs, one should be removed, or at least shortened, preferably to a lateral that will develop so that the scaffolds no longer interfere.

4. Where young trees have been neglected or not properly trained, and scaffold branches are closely parallel, one or more should be cut out. If two limbs are concerned, the weaker, preferably the lower, is removed. If there are three or more, space by removing the middle one.

5. Do not permit double leaders or whorls of main branches to develop.

6. Keep water sprouts removed except where needed to develop an important limb, or where they can be used for "natural bracing" of weak forks[3] (see Fig. 15).

7. Modify the leader as necessary, usually by the time the tree is 4 or 5 years old. Four to eight lateral scaffolds, in addition to the leader (which is modified into the upper lateral scaffold), will develop a splendid framework for an apple tree. Secondary branches from these will build the tree to desired height and spread (see Fig. 16).

[3] Two water sprouts or small branches can often be used to twine together and form a natural brace limb to support a crotch. Tie at each end and middle for the first year or two, allowing terminals of each to grow naturally until the two branches grow together, then remove ties and cut back terminals to length of brace limb. Brace limbs grow best if one arises considerably higher on the tree than the other, and grow more slowly as they approach the horizontal. Natural limb braces will increase in strength as tree becomes older. Single water sprouts can be bridge grafted into a brace limb and grow better than entwined brace limbs.

8. Remember that the lower limbs, being the oldest, come into bearing first, and should be used for fruit production as long as the quality is satisfactory. As thin wood develops in the lower and inside areas, it should be pruned away. Later, "thin wood" pruning is needed higher up and farther out in an increasing degree.

Bending or Tying Down Branches.—A special practice, sometimes used to train upward branches on dense young trees into outward growing laterals, is bending or tying down. For varieties such as Northern Spy and Yellow

(*a*) (*b*)

Fig. 15.—Two water sprouts can be intertwined and tied to form a natural graft brace limb to strengthen a weak crotch. In subsequent growth, a strong permanent brace limb is developed as in (*b*). Caution pruners to leave them and not cut them off as "freaks."

Transparent, it can be used to open trees without pruning them. It seems to promote early bearing.

One way to tie the branches down is to drive a staple in the trunk near the ground and run a piece of binder twine or heavy cord from the staple and tie with a large loop around the branch, well out on the limb, so as to hold it down in a spreading position. If done in the spring, fruit bud formation is encouraged during the summer. After being tied down a year, the branch is fixed in position and the tie *should be removed*. Padded, notched sticks in the crotches are also used to spread limbs apart, but this method does not bend as well as tying down.

Training Young Top-worked Trees.—In recent years, many orchardists have planted hardy understocks, such as Virginia Crab and Hibernal, on which desirable commercial varieties are topworked to secure hardier trunks and scaffold unions. The training of the understocks after planting can be done as recommended for training 1- and 2-year apple trees. As desirable scaffolds are secured, they can be budded about 15 to 18 inches from the trunk during the summer, or whip grafted in the spring.[4]

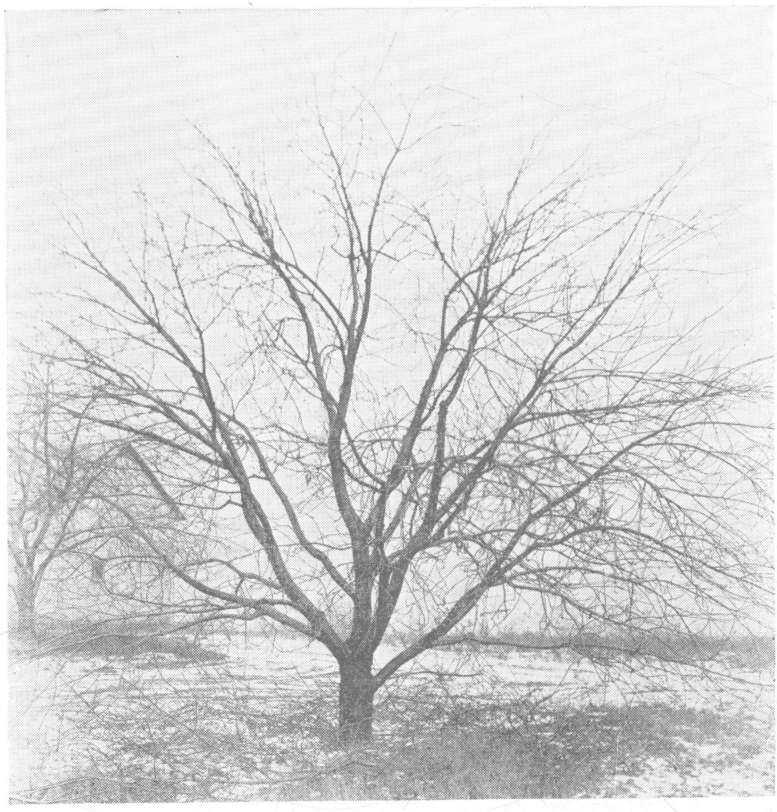


Fig. 16.—A well-pruned Rome Beauty apple tree trained to a modified, central leader with strong, well spaced, side branches.

Summer budding is preferred, wrapping the bud with nurserymen's budding rubber strips. Lateral buds can be cut from terminal growth in early summer as soon as the terminal bud has been laid down. The budding rubbers do not have to be removed, but drop off as the branches increase in circumference after budding. Buds set in the early summer usually start to grow soon after set, developing a branch beyond which the understock variety is pruned away the following spring. After topworking, the branches can be trained as recommended for young trees.

[4] Ellenwood, C. W., T. E. Fowler, and C. A. Greene—"Budding and Grafting on Hardy Apple Stocks." Ohio Agl. Exp. Sta. Spec. Circular 65. 1942.

Training Dwarf Trees

Dwarf apple and pear trees are increasing in popularity for home fruit plantings. Dwarf trees bear at an early age, and can be sprayed conveniently with home garden spray or dust equipment. Also, they can be planted in restricted areas or trained in various patterns against walls or buildings, grown on a trellis, or planted closely in hedgerows along walks, drives, or borders. The root system of dwarf trees is restricted and, to prevent damage by blowing over, it is advisable to tie the trunk to a stake on the side of the prevailing wind, except where some form of support is otherwise provided.

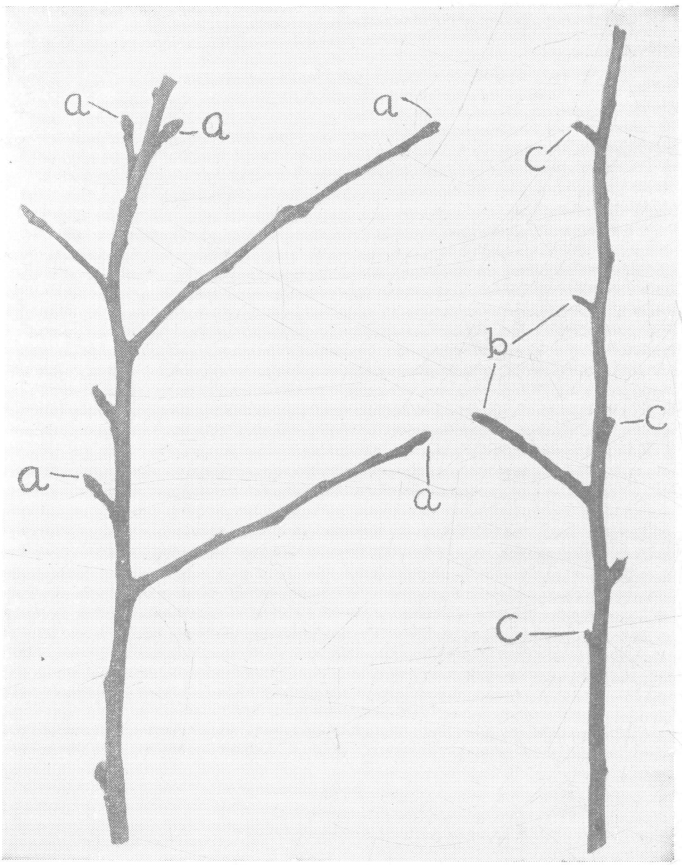


Fig. 17.—A bud study of apple wood. The buds *a* are large and strong and are probably fruit buds. Buds *b* are small and pointed, and are probably leaf buds. Where there are several large, healthy leaves on the spur to feed it, buds like *a* develop. Where there is a small leaf surface attached to the spur, a bud like *b* develops. Where there are no attached leaves on the spur, the buds die out as at *c*.

A screw-eye in the trunk at about 1- and 2-foot levels, from which a wire tie is made to the stake, provides satisfactory support for specimen trees.

The pruning and training is given as described for standard trees, except closer branch spacing must be given. Heavy pruning of the top to train various Espalier or Cordon patterns does not prevent bearing, as such pruning would with standard trees. Branches can be bent and tied in place during the growing season to assist in developing any pattern desired.

Plant tree with point on trunk where variety was grafted or budded at ground line or slightly above, to prevent roots growing from the top. If they

were allowed to grow, they would soon develop a standard tree. Where the bud or graft union is below ground, remove soil once a year and remove any roots which may have developed from above the bud or graft union.

Pruning as Related to Growth and Production of Bearing Trees

The bearing tree is pruned to improve quality, and increase the quantity of marketable fruit. Pruning also improves color, assists in controlling insects and diseases, increases size of fruit, and keeps the fruiting wood on old trees vigorous. With some varieties, such as Jonathan, McIntosh, and Rome, pruning will largely take care of needs of thinning and at less cost per tree.

Fig. 18.—Stayman apple which has become dense and matted. This wood is too crowded to be sprayed thoroughly, and produces small, poorly colored fruit. Note kind of pruning given in Fig. 19.

Terminal Growth.—As the tree comes into bearing, the production of fruit and the increasingly large top tend to vary the growth in different parts of the tree. The trend is for annual growth to decrease in length and caliper with each succeeding year, until fruitfulness is affected. Pruning, together with thinning and a desirable soil management program, then becomes necessary to control the kind and amount of fruiting wood to maintain production of large size quality fruit. With young trees, it is desirable to get all the terminal growth possible, often 24 inches or more, but still ripen the wood for winter. With bearing trees, a plump terminal growth on fruiting branches of 10 to 15 inches is desirable, with the longer growth desired for such light setting varieties as Delicious and Stayman Winesap.

Fruit Spurs.—Fruit spurs must be kept in a vigorous condition. In old trees, fruit spurs often become undersized, and annual pruning, with cuts well

distributed, is needed to keep the trees at the proper growth standard. Large spurs are correlated with large, well colored fruits.

Individual fruit spurs on an apple tree usually do not bear every year. The year a spur bears, it sets a terminal leaf bud for the following year. Thus each spur tends to have a biennial habit of fruiting.

Some varieties grow short fruit spurs that are rather uniform in growth habit and tend to blossom profusely in the same year. Such trees tend to bear biennially, as Baldwin, York Imperial, Wealthy, and Yellow Transparent.

Other varieties grow fruit spurs of unequal length. As a result, only a part of these spurs bloom and fruit one year, while some of the others bloom and

Fig. 19.—Thinning-out cuts followed by "thin wood" pruning on this Stayman will improve size, color, and quality of the apples that will grow on these lower branches. Spraying can now be more thorough and with less material.

fruit the following year. Such trees tend to blossom and bear annually, as Jonathan, Grimes Golden, McIntosh, and Stayman Winesap.

Other varieties lie between these two groups. When properly grown, they may bear annually, but they easily become biennial or irregular as they grow older or as cultural treatment becomes insufficient. Examples of this type of tree are Delicious and Jonathan.

Still other varieties fruit from terminal buds as well as from spurs, and tend to be annual bearers, because some terminal fruit buds are usually formed every year. An example of this type of tree is Rome Beauty.

Even with annual bearing varieties, especially on older trees, pruning with other orchard practices is necessary to keep spurs of unequal growth, and the trees in an annual bearing condition. When too many growing points blossom and fruit, conditions are unfavorable for fruit-bud formation during the early

summer of the overload. Pruning reduces excess undesirable blossoming and fruiting branches, preventing overloads in marked degree, thereby inducing more regular bearing.

Pruning Related to Fruit-Bud Development.—Usually, the buds on fruit spurs are all alike at the start. Whether they become fruit buds, leaf buds, latent buds, or dead buds depends on the food supply they receive. The buds with one leaf seldom get past the leaf-bud stage, but with three or more large leaves on a spur, the adjacent bud may develop into a fruit bud. For this reason, it is desirable to have several large, efficient leaves on each fruit spur. To secure such leaves, it is important that plenty of sunlight reach them. Pruning, therefore, should thin out the surplus limbs, especially weak growing underhanging limbs, so that sunlight can reach the remaining leaves on the fruit spurs of the branches making more desirable growth. With some varieties, detail and thin wood pruning are necessary to increase the supply of nitrates and water for the remaining leaves, fruit spurs, and terminals (see Figs. 18 and 19).

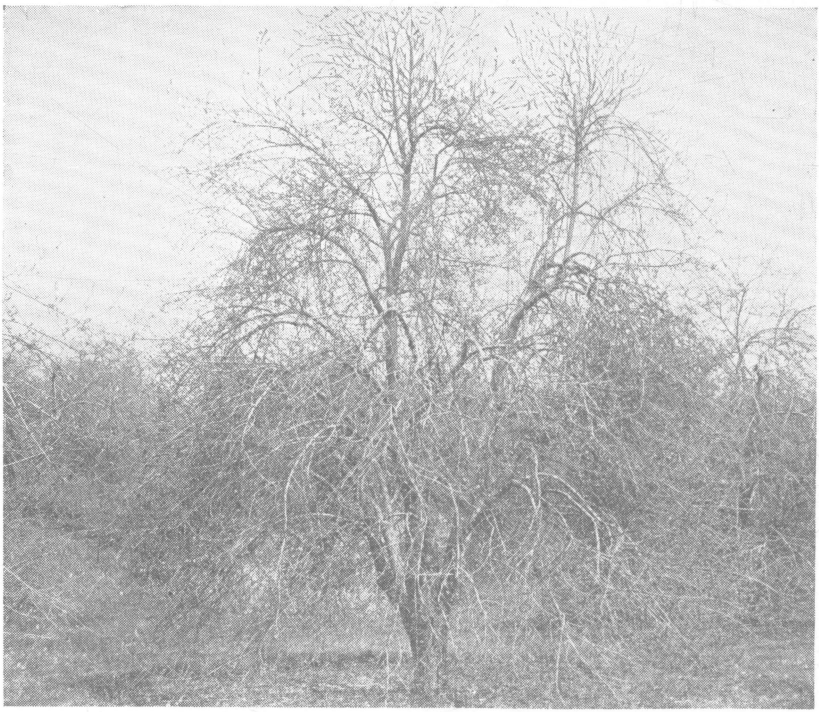


Fig. 20.—Old Rome Beauty apple showing deeply matted twigs at the ends of fruiting branches. This tree needs "thin wood" pruning with the hand shears, with cuts distributed over each main fruiting limb; very few large cuts are needed. Compare with Fig. 21.

Varieties which respond profitably to thin-wood pruning on mature trees include Rome Beauty, Stayman Winesap, Delicious, Golden Delicious, Mammoth Black Twig, R. I. Greening, McIntosh, Cortland, Baldwin, Jonathan, Northern Spy, York Imperial, Yellow Transparent and Wealthy.

Other Benefits of Pruning the Bearing Trees

Color Improvement.—Color in apples is determined largely by the interrelation of three basic factors: (1) the chemical composition of the fruit, (2) exposure of the fruit to sunlight, and (3) low mean daily temperatures. For the chemical composition of the fruit to be favorable for coloring, the leaves must be manufacturing a supply of carbohydrates (principally sugars) beyond the requirements for growth during the ripening period. Proper pruning assists in providing most favorable conditions for photosynthetic activity in the leaves, and secures most favorable sunlight exposure on the fruit.

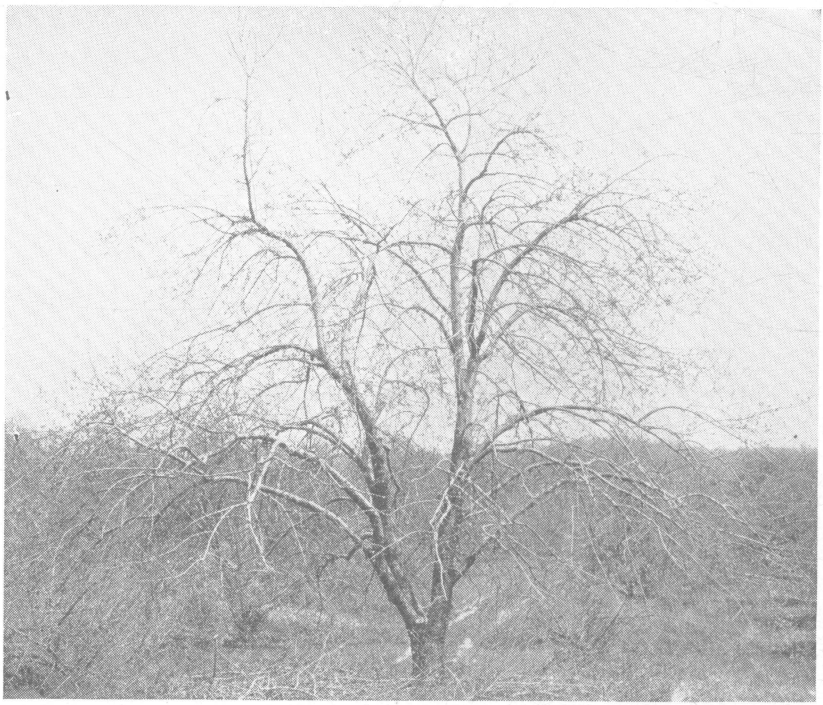


Fig. 21.—Old Rome Beauty similar to tree in Fig. 20 after pruning. Only a few large cuts were made. Pruning was started at top of tree. In working downward each limb was given thin wood pruning from tip back to base to leave fruiting wood on tree with best distribution over length of limb. Ladder was used to work over ends of high branches. Most wood was removed from inside lower third. This tree required two hours of pruning labor but little hand thinning of fruit will be required. Tree has bearing capacity of 30 bushels or more.

With Rome Beauty and Jonathan, proper pruning, with emphasis on thin wood pruning, has maintained satisfactory color development, with little opportunity for further gains in most years from hand thinning. With varieties which often set in clusters, such as Wealthy, Golden Delicious, and Grimes Golden, pruning helps the color, but, in addition, hand thinning is important for proper color development. Proper pruning should be given all varieties of bearing trees as a basic annual practice for color improvement. Hand thinning should be determined by the amount of fruit setting for the year and the varietal response.

Pruning Aids in Controlling Insect and Disease Pests.—Proper pruning corrects thick, matted branches and keeps trees in condition to be economically and efficiently sprayed with a minimum of spray material. As spraying usually represents about a third of the acre-cost of growing an apple crop, this is important. It is desirable that trees dry rapidly after rains or after being sprayed, to minimize development of diseases and spray injury. Such diseases as apple scab, apple blotch, bitter rot, brooks spot, and sooty fungus thrive in dense, humid areas of trees. It is necessary to spray all over an apple to control such insects and diseases as codling moth, apple maggot, and bitter rot. When trees are kept reasonably open by good pruning these pests can be controlled, and losses from aphis reduced. Likewise damage from limb rub is cut to a minimum.

Pruning Increases Size of Fruit.—Dormant pruning promotes rapid size development of fruit, beginning with fruit setting. Gains in size improvement from hand thinning cannot start until thinning is done, and often this is too late in the season to secure greatest benefit. Therefore, pruning is of decided helpfulness in securing desirable size with all tree fruits, bush fruits, brambles, and grapes. Pruning must be interrelated with other practices, especially thinning, use of fertilizers, and soil management, to secure greatest response in size improvement.

Pruning helps to eliminate unprofitable small apples. Its helpfulness increases as trees grow older and it becomes more difficult to keep fruiting wood vigorous. When carried to extremes, however, pruning reduces yield. Considerable study and skill is necessary to prune so as to produce the highest yields of good size, color, and all-around quality fruit.

Pruning Keeps Fruiting Wood Vigorous.—Almost every observing orchardist has noted the fine size, color, and quality of fruit on young trees that have just come into bearing. Then, little pruning is needed. But from year to year, the conditions change slowly to a lesser growth, thicker top, less color, smaller sized fruit, and poorer control of orchard pests. Pruning must be practiced in a way to keep the fruiting wood of mature trees approaching the ideal growth conditions generally found in young bearing trees. This means encouraging well placed new growth—fruiting it for a few years while it is vigorous and productive, and pruning it away as it becomes old, underhanging, thin wood. Proper pruning is a renewal practice that prevents cluttering bearing trees with old, undesirable, or barren fruiting wood.

Pruning Bearing Apple Trees

After trees reach bearing age, each year before picking, observe carefully where small, defective, and poorly colored fruits are being borne on typical trees of each variety and age group. Also observe fruiting branches which have ceased to be productive. These observations are best made by taking a position near the trunk and looking outward and upward through the tree.

A few notes taken at harvest time will be useful in indicating the kind and amount of pruning needed. Wood removed in pruning should consist chiefly of (1) limbs that have been overgrown by other limbs and no longer produce desirable fruits, (2) old, underhanging thin wood on branches that still carry

a good bit of desirable young fruiting wood, (3) surplus water sprouts, and (4) limbs that prevent good light and spray penetration through the trees, the removal of which is needed to keep the trees in condition to thin and harvest to advantage. In this way the minimum amount of pruning to improve the quality of the fruit will be done.

The lower limbs, being the oldest, need first attention. Drooping branches may need cutting back to upward or outward growing laterals to relieve congestion. Fruiting wood above a height of 20 feet is thinned and harvested with difficulty. Tops should be kept at a practical height, with the top center not too dense for thorough spraying. Branches that have become too tall (see Fig. 5), or that extend out in the rows and interfere with spraying and hauling, should be cut back to desirable laterals.

It is not necessary to remove crossed and crowding branches in the fruiting areas of the tree where they carry desirable, well placed fruiting wood. It is important to remove fruiting branches when they become undesirable and to keep tree filled with the right amount of fruiting wood of large caliper.

A common fault in pruning bearing trees is to leave a shell of unpruned branches around the edges of the trees, and to remove more inside and lower fruiting wood than necessary. The logical procedure is to try to secure the greatest benefit from the labor expended. A few suggestions follow:

1. Remove dead, broken, and diseased wood. Such diseases as bitter rot and black rot (frog-eye) are disseminated from dead wood which is allowed to remain in the trees from year to year.

2. Do needed corrective pruning, including the removal of any large limbs necessary to improve the shape of the tree. Use judgment in pruning, so that direct sunlight will not cause sun scald on remaining main branches. Direct exposure of bark on large limbs to southwest sunlight may cause sun scald.

3. During the first 15 years, most of the pruning needed will remove undesirable thin wood branches and limbs which have been fruited out or shaded

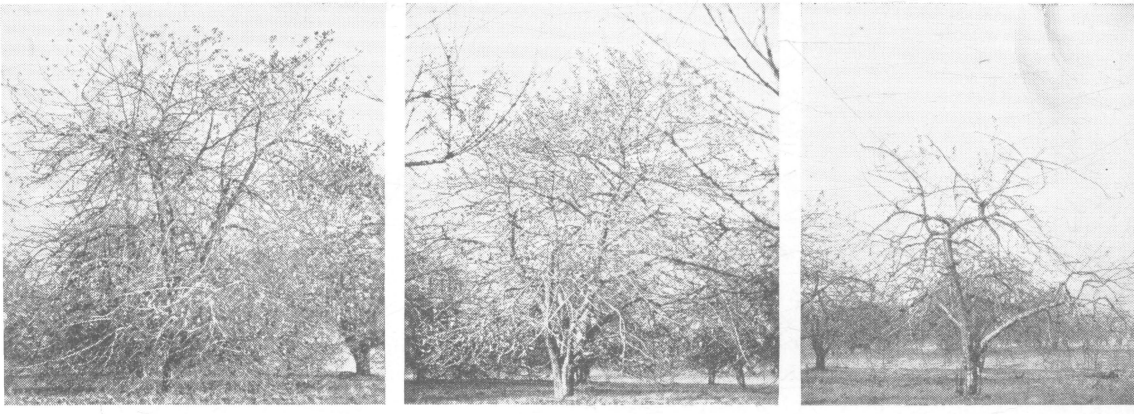


Fig. 22.—Pruning is a dwarfing process. These 27-year Stayman Winesap trees in the Ohio Agricultural Experiment Station orchard at Wooster show growth response following variations in pruning. The large tree at the left has never been pruned, the tree in the center has received moderate pruning, while the one on the right has been given heavy annual pruning. The average yield in pounds per tree for the 10-year period 1933-42; unpruned 553, lightly pruned 606, heavily pruned 467. Fruit from the unpruned tree was small and unsatisfactory during this period.

out from the lower inside of the tree. By keenly observing the tree each year, the kind of wood that should be removed will be readily determined.

4. To complete all over pruning of the tree, start at the end of each large branch carrying some undesirable wood, and distribute cuts, working back to the base of the limb. Underhanging thin wood branches are detected and removed in this procedure. On old trees it is necessary to use ladders to detail prune the matted branch ends, particularly with twiggy growing varieties such as Rome Beauty and Northern Spy.

5. Bearing trees can be kept in best condition by annual dormant pruning. This is helpful in promoting regular bearing. Very good results follow the practice of arranging the needed pruning every other year just ahead of the

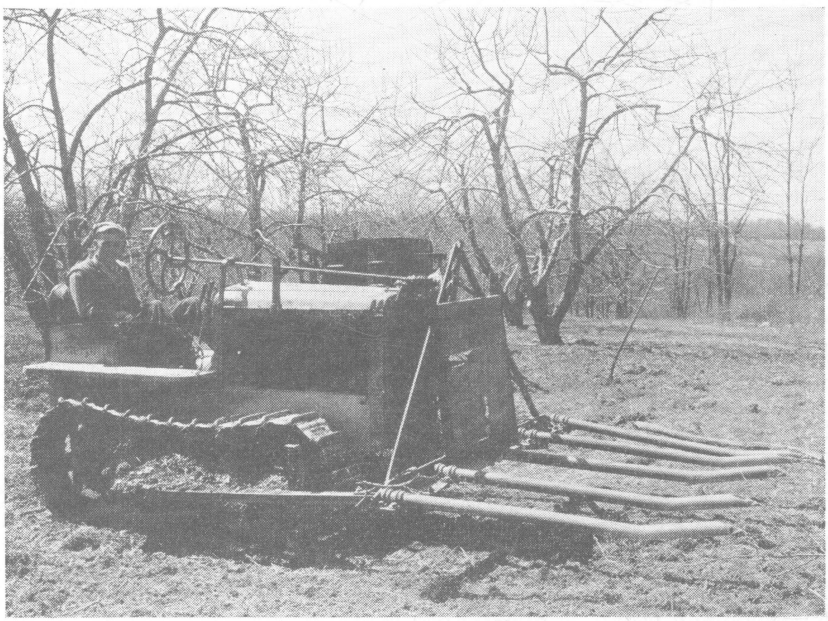


Fig. 23.—Prunings thrown in the middle of the rows just beyond the spread of branches are quickly collected and pushed to piles with brush rake operating like a buck rake attached to the front of a tractor. (Photo by courtesy of Ohio Agl. Exp. Station).

expected "on year" of heavy cropping. Such pruning prevents blossom and fruit overloads to a large degree, and reduces the labor expenditure in hand thinning. Where pruning is very irregular many trees grow out of bounds and develop irregular bearing habits, with undesirable overloads that further exhaust the tree during seasons favorable for heavy cropping. There is least risk from winter injury when pruning is done in late winter and early spring.

6. Remove water sprouts, except where you can train into a branch to fill a vacant space.

Rejuvenating Old Trees

Sometimes in a neglected orchard, the lower limbs are dwarfed and even tually killed from lack of pruning. The top limbs continue growth unhampered.

Under such conditions the tree becomes too tall to spray or harvest economically. If the lower limbs have been dwarfed but not killed, it is possible that the trees may be profitably lowered. Tall top branches can be headed back to strong side branches. Care must be taken that such a pruning does not leave weak branches at the cut, or it may result in bad breaking. Care must also be used not to make a large opening in the center of the tree, because such openings cause sun scald on the main scaffold limbs.

Fig. 24.—(*a*) A length of woven wire fencing is a convenient device for hauling brush. Fencing is nailed to a cross frame at each end with length of chain or cable attached to rear frame. (*b*) Cable is thrown forward over load and used to pull and roll off brush where piled.—(*Courtesy Ohio Experiment Station*)

Real skill is required for a successful rejuvenation of old trees. If a grower is in doubt as to what to do, he should depend almost entirely on thinning out the branches in the tops. It is usually best to lower gradually the tops of neglected trees over a period of about 3 years.

Apple trees respond best to cultural practices up to about 35 or 40 years of age. It seems better to recommend under present conditions of production and marketing that most neglected old trees be removed from the orchard rather than attempts be made to rejuvenate them.

Crowded Trees

Frequently, orchards of mature trees are found where the planting distance was too close. The trees have become crowded, and side branches interlace. Most of the productive wood is in the tops of the trees. The first problem here is to do something to get abundant sunlight on all sides of the best trees. Sometimes cutting out the diagonal rows to stagger the trees relieves the situation. Trunks of filler trees can be marked with paint, and heavy pruning given them as needed to prevent crowding until finally removed.

After the trees in a crowded orchard have been intelligently spaced, the remaining trees can be properly pruned. They often produce more and better fruit than could have been secured had all the trees been left.

Fig. 25.—A brush burner is practical in young orchards and where the heat from the burning brush will not be too close to damage the trees.

Disposal of Brush

Brush should be removed promptly and burned each year. This practice aids in the control of insects and diseases. For large orchards with long tree rows on relatively level land, a brush rake attached to the front of a tractor is the most economical method of disposal. A brush burner, made by cutting open a section of a large sheet iron smokestack (see Fig. 25), and mounting it on skids, is satisfactory for young orchards, where the heat will not damage trees as the burner is pulled through, and where there is no fire hazard.

Sections of woven wire fencing (Fig. 24) or sleds are often used to haul brush to piles, where it can be burned.

Pruning Adapted to Varieties

Rome Beauty.—As young Rome Beauty trees come into bearing, they assume a spreading habit under the weight of fruit. Gradually the lower branches become filled with shaded wood and, due to the twiggy growth habit of the fruiting branches, the ends become deeply matted with small twigs unless pruning is properly done.

Hand shears must be used in thin-wood pruning of bearing Rome Beauty trees, to open the thick areas at the ends of the fruiting branches. Each large branch is pruned as a unit from the end back to the base, distributing the cuts as well as possible and removing "run-out" weak wood. It is important that the cuts be well scattered. Remove underhanging slender branches. On old trees it is necessary to prune from ladders, placed to reach the outer portion of each large limb.

A common mistake in pruning bearing Rome Beauty trees is to start at the base of a large branch and prune outward, taking off all branches for a considerable distance, which leaves a long stretch of naked wood toward the base of the branch, with a cluster of unpruned bushy twigs at the end of the branch.

Well pruned bearing Rome Beauty trees need a relatively small amount of hand thinning of the apples during the growing season.

Stayman Winesap.—On soils and culture that favor strong growth, this variety tends to develop many leggy branches without well placed laterals. Heading-back to induce a desirable amount of lateral branching is necessary on young trees where unbranched terminal growth approaches 30 inches or more. Stayman Winesap is an open grower, requiring a relatively small amount of large branch removals except where corrective cuts, necessary to avoid double leaders or weak crotches, are necessary.

This variety is prone to develop many sharp angled, weak forks. Corrective cuts to eliminate these structural weaknesses are important. The wood splits easily. Large top cuts, used in heading back to laterals, must be made with caution. Frequently, water sprouts can be intertwined between weak crotches, to make a natural brace and strengthen framework. Because it is an open grower, lopping shears can be used considerably in the pruning work. High vigor is needed in the fruit spurs of Stayman Winesap to improve set, as this variety has serious pollination weaknesses. Small cuts, well distributed, give a larger food supply to the remaining fruit spurs. This type of pruning is very helpful with this variety. Keep terminals growing 15 inches or more on bearing trees to induce annual bearing (see Figs. 18 and 19).

Jonathan.—Jonathan trees grow many small branches and twigs. Soon after the trees come into bearing, shading develops in the lower part of the tree. Branch spacing and thin-wood pruning in this area will encourage production of high quality fruit. This variety does not respond well to heading-back cuts. Limbs headed back to relatively small laterals are frequently seriously stunted. It is best to confine pruning to branch removals, and then distribute small cuts on the remaining branches.

Pruning is relatively more important in improving size of fruit with Jonathan than is hand thinning. Thinning experiments show a rather narrow margin of actual profit on well pruned Jonathan trees.

Baldwin.—If this variety is grown with relatively little pruning, biennial bearing develops rather quickly. The amount of pruning on Baldwin can well be increased soon after trees begin to bear, and this will tend to reduce the strong tendency toward biennial bearing, especially if done in the winter and early spring ahead of the expected heavy blossoming. As this variety is a strong, dense grower, branch spacing is important to admit light to the more desirable limbs. Lopping shears and hand shears can be used to scatter small cuts. As this variety tends to overbear, hand thinning in addition to pruning is important to improve size, color, and quality. Thin-wood pruning improves size and quality.

Grimes Golden.—A characteristic of Grimes Golden is to bear its fruit relatively deep in the tree. Therefore, the small branches and spurs which arise toward the base of the larger limbs are quite important in fruit production with this variety. As trees become dense, the removal of large limbs to secure branch spacing is important. This allows light penetration between the limbs. The excessively heavy areas of fruiting branches can be thinned with lopping shears, beginning at the end of the branch and working back to the base. It is a great mistake to "cowtail" prune the large branches of Grimes Golden. If the medium sized limbs and spurs are entirely cleaned off the base of the main branches, yields of fruit are reduced, as previously pointed out, and the most fruitful areas of the tree are largely lost.

Grimes Golden responds splendidly in improvement in size and quality from hand thinning. Even on well pruned trees, hand thinning is important, as undersize fruit is a serious problem with this variety.

Delicious.—Like Stayman Winesap, this variety is subject to weak crotches and grows many branches in whorls. Corrective cuts to space the most desirable main branches are important. Water sprout bracing can often be used to advantage in bracing weak crotches. Delicious develops too many medium sized branches, and trees become dense unless removal of these limbs is done with lopping shears and saw. Since this variety is more profitable when grown as a large fancy eating apple, it is important that branch spacing first be secured to admit sunlight, and that this be followed by removal of underhanging thin wood branches.

Delicious has a varietal weakness in fruit setting, and detail pruning with hand shears will greatly improve the set of fruit and secure a yield consisting of a high percentage of large, well colored fruits. Hand thinning is important with Delicious. Keep terminals growing 15 inches or more.

McIntosh.—The general habit of growth of the McIntosh is quite satisfactory. Adequate limb spacing is important to allow thorough spraying for pest and disease control, especially scab. Never allow the tops to grow too tall or dense to spray thoroughly. Fruit is improved more by pruning than thinning. So, follow a plan that keeps all fruiting wood vigorous. Remove underhanging thin wood as it appears, and this will favor good sunlight exposure on all fruit spur wood to improve color. Keeping trees well mulched is helpful in improving size, color, and quality, and gives greatest value to dropped fruit.

Northern Spy.—As a young tree, the Northern Spy is very dense, with decidedly upright growth habit. It is naturally late coming into bearing (about

12 years) and fruiting often is still further retarded by heavy pruning. Watch closely to prevent forks and narrow-angled branches in the framework. Tying down some of the upright branches is often effective in opening the trees, and demonstrations indicate this is an aid to early fruiting. As trees get older, considerable thin-wood pruning, working from a ladder, is required at the ends of the large fruiting branches as described for Rome Beauty. This will also reduce limb rub injuries to the fruit, so common with the Northern Spy, and will make conditions better for scab control.

Golden Delicious.—This variety is an early bearer (about 5 to 7 years) and training cuts are not as apt to retard fruiting. Special attention is needed to keep forks and narrow-angled limbs from developing. As there are so many branches from which to select, it is not difficult to develop a strong, well-spaced scaffold system. Keep main branches well spaced to encourage large diameter, as leggy branches are very brittle. Modify the leader by removing small branches on the side toward the prevailing wind. Fruiting will then help pull the leader into a side branch. Remove surplus thin wood to grow apples to large size.

Yellow Transparent.—This variety grows too many branches and often becomes too dense. When the main branches are well spaced the weight of fruit spreads the tree quite satisfactorily. Very little topping to outward growing laterals is needed where the right amount of large branches is removed by pruning. Small cuts, well distributed on branches which are left, help considerably in improving size. Increase the amount of thin-wood pruning as trees get older.

Yellow Transparent is greatly benefited by pruning just ahead of expected heavy crops and by hand thinning completed about a month after bloom. It is becoming increasingly difficult to sell small Yellow Transparents. Both pruning and thinning are needed in a relatively high degree to improve size of this variety.

Wealthy.—Color is important with Wealthy, and the pruning program should never allow the trees to get thick. If Wealthy is allowed to overbear, it becomes a weak grower and a biennial cropper. It is important that considerable thin-wood pruning be done to promote the most vigorous growth. Long terminal growth on all important branches should be the aim with Wealthy. Hand thinning early in the season greatly reduces the 2¼-inch fruit and vastly improves color.

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PRUNING THE PEAR

The young pear tree is trained and pruned to the modified leader system as recommended for the apple, with about six main scaffold branches. Light pruning is recommended, as blight is more difficult to control on both young and bearing trees where annual growth is softened by heavy pruning. It is particularly important to confine cuts to the thinning-out type, with occasional removals of upright limbs to desirable laterals. Heading-back cuts should be avoided, as these encourage a profusion of soft terminal shoots. Tying down can be used occasionally instead of pruning, to spread growth. Depend on

fruiting and not pruning to spread the tree. When too high to spray and harvest, lower the tree by making thinning-out cuts to desirable lower outward laterals.

If necessary to cut any blighted branches during the growing season to save important limbs, cut a foot or more below the lowest point where blight is showing, and promptly disinfect shears or saw and wound with a solution of 1 to 500 bichloride of mercury (poisonous) and 1 to 500 cyanide of mercury (poisonous) mixed together. To apply disinfectant conveniently, put it in a bottle, tie a sponge over opening, and dab wound with wet sponge.

Water sprouts and spurs should be removed from trunk and lower portions of main limbs to eliminate this source of direct entrance of blight as a body canker. Blight can be pruned away with least danger of spreading it when the tree is dormant. It is recommended that this work begin about September 1, when blighted twigs contrast easily against normal leaves and growth.

Pears are best grown in close heavy sod with mulch. Avoid manure applications and cultivation, as both create a susceptibility to blight. Nitrogen fertilizers should be used on mature trees only when growth and fruiting become unsatisfactory.

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PRUNING THE PEACH

Pruning the Young Tree

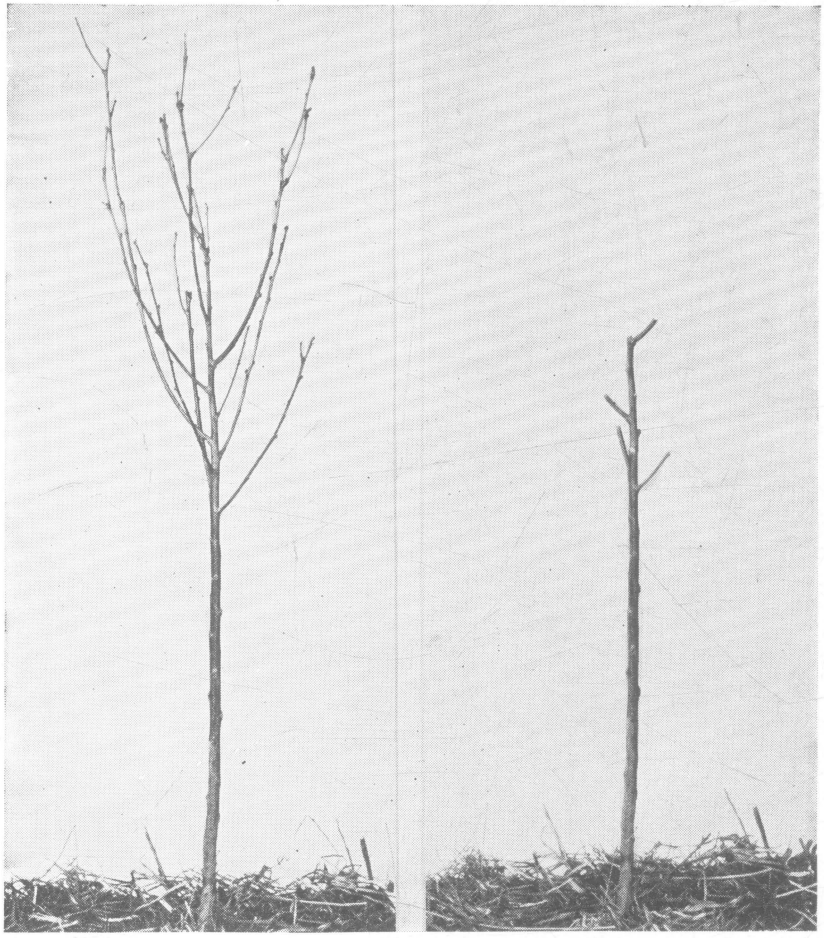
Age of Tree to Plant.—Well grown 3- to 4-foot yearling trees of about ½-inch diameter are preferred for planting. Never plant older trees or small, weak yearlings. Planting in early spring is preferred.

Pruning at Planting.—The usual method of pruning, which can be adapted to any kind of yearling tree, is to select four or five laterals well spaced vertically and around the trunk, with the lowest about 12 inches and the highest about 24 inches from the ground. Remove all other branches and cut back those selected to short spurs of from 2 to 4 inches, with one or two buds. Head-back the trunk to the upper branch. If no desirable laterals are available, head to a whip at about 24 inches and side branches will develop. Heading lower than recommended will increase the labor of gassing with paradichlorobenzene to remove borers. Leaving lateral spurs helps develop a symmetrical head during the first year's growth (see Fig. 26).

Pruning the Second Year.—After the first year's growth, select four or five strong, outward growing scaffolds well spaced around the tree to form the head. Remove all other branches originating on the trunk. Try to get 2 to 4 inches of vertical distance along the trunk between scaffolds. Cut out any strong, upright, central shoots and those that cross the head. Train to a symmetrical, open-bowl type tree. The lateral scaffolds should be headed back only where growth is excessive without branching. Leave one or two strong secondary laterals on each main scaffold, with none closer than 15 inches to the trunk. Secondary lateral limbs are best trained somewhat upright and to the outside.

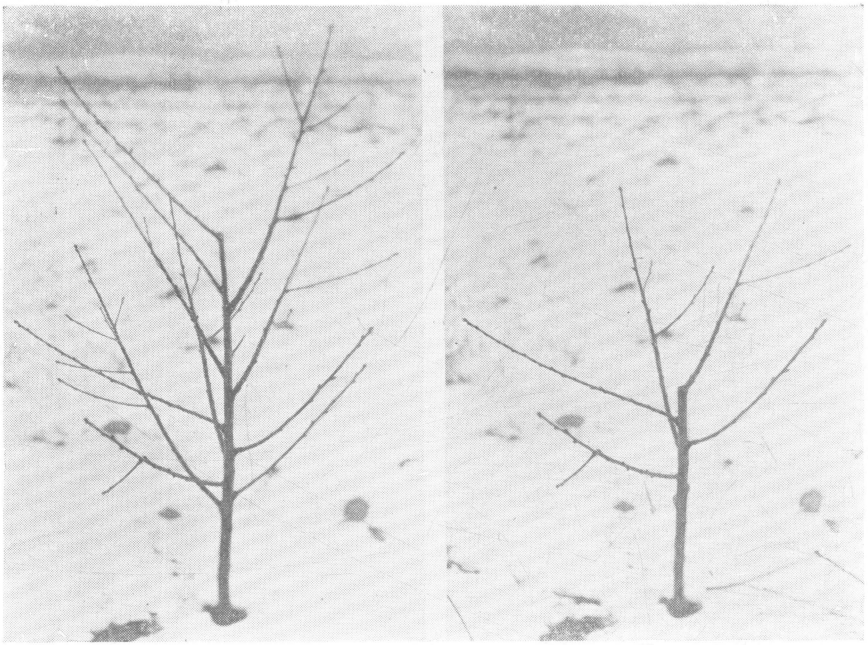
Where growth is branched and not more than 30 inches, the training is best given with thinning-out cuts and cuts to outward growing laterals to develop an open, spreading tree. Injury to terminals during the growing season from oriental peach moth often stimulates considerable lateral branching. Where this injury is excessive and trees become too dense, some of the laterals should be thinned out. Where growth is very dense, some thinning-out pruning during the summer is helpful to direct growth where wanted.

Special Problems in Starting Head.—Sometimes, particularly if winter injury to wood is serious the first or second winter after planting, the scaffold branches selected are stunted and one or more strong shoots arise from the trunk below the scaffolds selected. In such cases, it is best to prune away the old scaffold and build a new one from the vigorous, low branches. Often the



(*a*) (*b*)

Fig. 26.—(*a*) One-year-old peach tree after planting. (*b*) Same tree after pruning. The tree was cut back to about 24 inches. Four well distributed side branches were left and cut back to short stubs to assist in developing symmetrical open head.



(*a*) (*b*)

Fig. 27.—(*a*) Peach tree after one year's growth in the orchard. In pruning at planting time, tree was headed too high, which resulted in weak growth of low side branches. (*b*) Same tree after pruning. Note that central wood has been removed, leaving well spaced scaffold branches to develop an open center peach tree. No cutting of side branches has been made.

Before *After*

Fig. 28.—Deshooting is an effective method of establishing strong framework on peach trees. The 1-year tree is cut to 2½ feet at planting, and the lateral shoots are cut to 1 to 2 buds. When shoots are 8 to 12 inches long in June, 4 to 5 well-distributed ones are selected as shown on right, above. (Photo, courtesy Ohio Agl. Exp. Station).

best one of these which arise above the "bud" can be headed and the others removed. Then scaffolds are trained from the new trunk selected.

Modified Deshooting Method.—This method has received considerable attention in recent years. To use it, plant a yearling tree of at least 5/8-inch diameter and height of at least 4 feet. Small trees are unsuitable. The tree is headed at about 36 inches and all branches are removed below 12 to 15 inches from the ground. The rest of the side branches are cut back to stubs of one bud each (see Fig. 28). When the shoots are about 6 or 8 inches long, in early summer, go over the trees and select four or five of the strongest

Fig. 29.—An Elberta peach tree started with a modified open head. Scaffold branches have been well spaced and trained by cutting to outward laterals, develop ng an open center bowl-shaped tree.

wide-angled shoots and try to space them 4 to 8 inches apart, vertically and well distributed around the tree. Sometimes, the shoots are thinned down to leave only the best in early summer, and final selection of the scaffolds is deferred until pruning the following winter or early spring. Select scaffolds leaving trunk at a wide angle to form a strong crotch system for the head.

At pruning time, select four to six well spaced and distributed branches and see that no one of them is directly over another. The stronger growing ones are cut back to about the length of the short one, with the lower branches left somewhat longer than the upper ones. All other branches except the scaffolds selected are removed. Later the training is similar to that described for ordinary training in developing an open-bowl shaped tree. This method has some advantages in reducing crotch injury and the splitting down of scaffold limbs.

During the early summer of the second year go over the trees and rub off undesirable shoots growing from the leader, to confine growth from the trunk into the selected scaffolds. The head of the tree is now established and future training will be to develop symmetrical open growth. Some thinning out will be needed and occasional cutting back to outward growing laterals to develop an open type of tree.

Pruning the Third Year.—The tree should now be well formed, and only very light corrective pruning needed to keep the center open and main branches well spaced. Keep the older small branches arising near the base of the scaffolds on the tree, except for light thinning out where very dense. These small branches are often the first to bear, and too often the first and second crop is

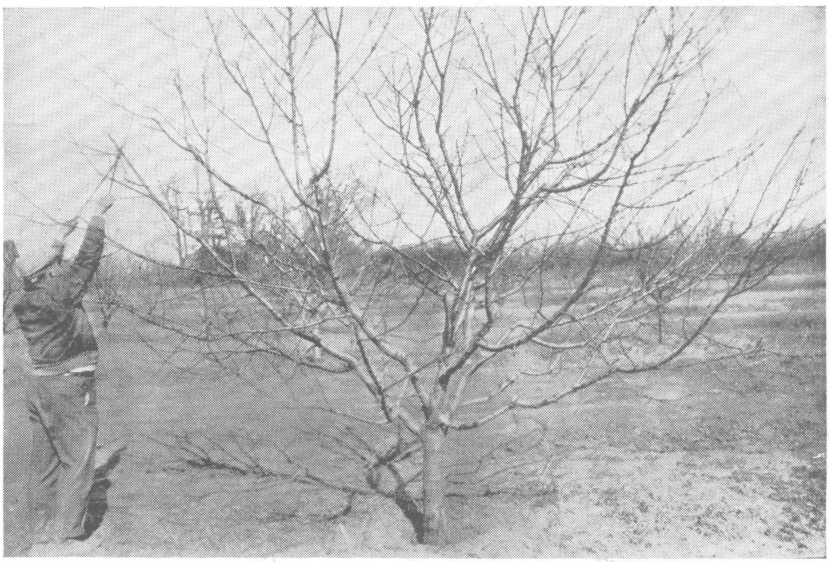


Fig. 30.—Bearing peach tree before pruning. Renewal cuts are being placed at desirable outward growing laterals at height of about 8 feet. Lopping shears are convenient for this work. All fruit buds are alive on this tree and pruning is of the general all-over type. Compare with Fig. 31.

thoughtlessly reduced by pruning them off just to make the trees look better. As with apples, the lower branches on peach trees should be fruited as long as the quality of the fruit is satisfactory.

At this age, heavy pruning will reduce yield without improving size of fruit. Some thinning-out summer pruning, to prevent any areas from becoming dense, will help fruit bud formation deep in the tree. Let sunlight reach all the foliage. Fruit buds on the peach form in late summer. So, keeping trees from becoming dense then, helps fruit bud formation.

The advantages of light pruning of young peach trees has been confirmed by experimental work in various states. An Ohio experiment with light and heavy pruning gave conclusive evidence that heavy pruning seriously reduced the yield during the fourth and fifth years from planting.

Pruning the Bearing Peach Tree

Bearing Habit.—Peach trees bear fruit on wood that grew the previous year. Terminal and lateral shoots over the outer surface of the tree are, therefore, important in fruit production. When trees are kept open throughout, a considerable amount of new shoots and short growths or spurs develop each year rather deeply throughout the tree. One should recognize this fruiting habit in the pruning program. A low, open head, to develop an open-bowl shaped tree, is, therefore, favored.

Fruit buds are plump and roundish, while leaf or branch buds are small, narrow, and pointed. On vigorous terminals and shoots, the buds are often grouped in three's, with a fruit bud on each side and a leaf bud in the center.

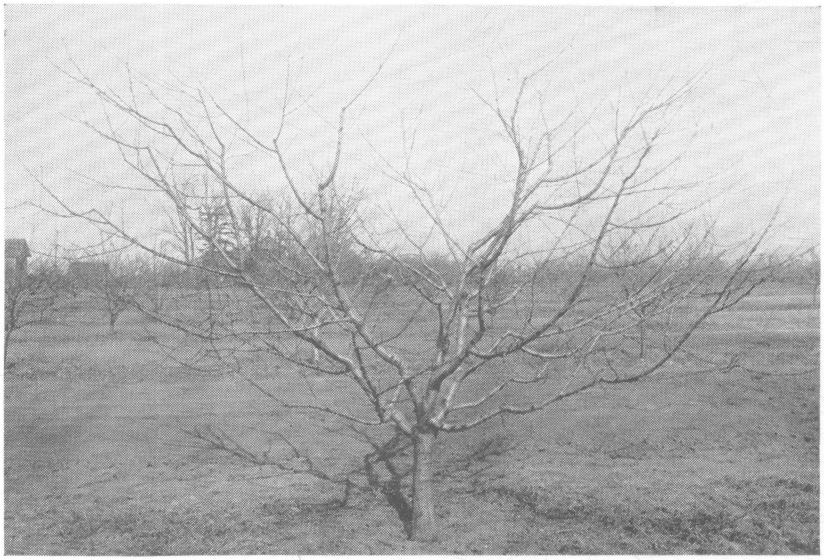


Fig. 31.—Same bearing peach tree shown in Fig. 30 after pruning. Note open center and uniform thinning throughout to promote fruiting wood renewals deep in the tree. All upper main branches have received a renewal cut placed at outward lateral of convenient height. A prominent upright branch was removed at each renewal cut.

On shorter growth and spurs, fruit buds are often borne singly. Leaf buds occur without adjacent fruit buds on the ranker growths of 30 inches or more, particularly on the lower portions of these branches.

A well-grown peach tree usually begins bearing the fourth year. At this age, pruning is light, with a few cuts to keep the center open and bearing wood thinned as necessary to keep it from getting dense. Well-grown bearing peach trees seldom fail to make enough fruit buds for a heavy crop. Usually, far too many are produced, and pruning is helpful in thinning the crop, as well as in providing conditions for proper renewals of fruiting wood throughout the tree. It is important that the bearing trees be pruned every year. Otherwise, the tendency is for the fruiting wood to develop farther out and higher up each year, and a thick-topped, leggy tree quickly develops, without low fruiting

wood. Terminal growths of from 10 to 20 inches maintain fruit production in bearing trees satisfactorily.

When and How Severely to Prune.—Pruning practices for bearing peach trees in Ohio are largely determined by the kind and amount of winter killing of fruit buds and wood. Fruit buds killed by low temperatures have dark centers when cross sectioned, and do not blossom. Winter injured wood shows browning, and may kill to the pith. Usually about 10°F. below zero is critical for dormant fruit buds and 20°F. below zero is critical for dormant wood, with considerable variation by variety and growth conditions. The last tissue to kill is the cambium (between inner bark and sap wood). Often most cambium injury occurs on trunk and lower portions of scaffold limbs.

It is recommended that pruning be delayed until after danger of winter killing of buds and wood is past, at least until late February or early March. The proper amount of thinning-out pruning, with large cuts as needed, can then be given. If no winter injury to fruit buds has occurred, give also a general all-over pruning.

When a portion of the buds are killed, give a very light pruning, because heavy pruning would reduce yield without improving quality. Usually, the most live buds are then in the tops of the trees, and pruning should be planned to make the best of the prospect and not cut off too much high wood carrying the live fruit buds.

If all fruit buds appear killed, delay pruning until blossoming time. Then, if no blossoms appear, use the opportunity to thin out and cut back sufficiently to keep the tree of desirable size, height, and with proper branch distribution and spacing to get fruiting wood renewals throughout the tree. Leave some small well placed laterals to direct new growth.

In sections where spring frost is as great a risk as winter injury, the necessary thinning-out cuts can be made in the dormant season, but the amount of heading-back is better deferred until after danger of frost injury is over, when the degree needed can be determined.

If crop is lost and wood severely injured there is great temptation to "dehorn" peach trees with large heading-back cuts in wood 3 to 4 years old or more. Experience has shown that cutting back to stumps of limbs after wood is severely winter injured is often fatal. Such trees should be lightly pruned after growth starts, and given a liberal application of a quickly available nitrogen fertilizer such as nitrate of soda in early spring, along with good culture, to restore growth conditions. After growth starts, remove dead wood as quickly as possible. If trees recover, place cuts at desirable growing points to lower, thin out, and spread top.

When uninjured peach trees are dehorned heavily, the resulting growth is too profuse and rank to train easily or to bear heavily for 2 or 3 years. Dehorning, therefore, can never take the place of keeping bearing trees right by well planned, annual pruning. Where trees have had some neglect and are leggy, and the crop has been killed but the wood uninjured, a mild dehorning may have a place. It is best to keep the cuts in wood that is 3 and not over 4 years old, with some of the prominent secondary branches left on the main limbs, and these given rather light heading-back. When dehorning, cut out entirely

the most objectionable upright branches in the center of the tree. Place cuts to form a low, open, and spreading type of framework.

Types of Pruning.—In maintaining the open-bowl type tree, a general branch thinning, with the shortening of main branches to outward laterals as necessary, must be followed. In general, the pruning is lighter during the first 3 or 4 years of bearing than later. After four or five crops, a heavier heading-back type of pruning is desirable, at least every 3 or 4 years, to keep desirable fruiting wood low. Clipping of all the laterals, as occasionally practiced to substitute for thinning, is expensive pruning and reduces yields. "Heading-back-only" pruning has the same objections. It is better to do both moderate thinning and cutting back to outward laterals as necessary. Then depend on hand thinning in heavy crop years to distribute the fruits for proper size and quality development.

Keep the centers of bearing trees open to promote desirable growth of new shoots on main branches and to secure best color on the fruit. Annual terminal growth of about 15 inches maintains desirable fruiting wood. Short slender growths are unproductive and are characteristic of declining trees. Trees that show several annual growths of 50 inches or more are trained with difficulty. The lower areas of these heavy growths are not fruitful.

Pruning, fertilizing, and soil management must be carefully interrelated to promote desired growth. In pruning, leave large branches well spaced to keep the lower branches growing and to prevent accumulation of dead twigs in the center and lower part of trees. When scaffold crotches need bracing, a good method is to run a loop of heavy galvanized wire around the inside of the main branches and attach to each main branch with an ordinary fence staple. If this loop is placed during the dormant season it will prevent overloads splitting the main crotches. The wire should slide in the staples to spread the strain. The wire and staples are usually placed at a height of 5 to 6 feet from the ground.

Placing Renewal Cuts.—As the trees reach a height of about 8 feet, it is important to cut the main upward growing branches back to outward laterals. This cut to a lateral will serve as a renewal point for several years. It is handy to make the cut at a height reached easily with lopping shears while standing on the ground (Fig. 30). A renewal cut should be placed on every main branch as soon as it reaches sufficient height to require it. The cut is ordinarily made in 2-year-old wood, but sometimes it is necessary to make it in older wood. Remove the largest upright branch at a prominent crotch at the renewal height (Fig. 31).

New shoots are encouraged near the renewal cut, and the best of these can be used the next year or two for fruiting. The larger upright branches near the cut are pruned away in succeeding years. In this way, the tree is kept within bounds and trained as an open spreading tree.

Often one or two cuts of the heavier upright wood near the renewal cut will be sufficient each year to keep the branches in bounds and the fruiting wood well renewed. On soils that promote development of large trees it will be necessary as trees get older to do a considerable amount of pruning, working from step ladders.

PRUNING THE SOUR CHERRY

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Fruiting Habit.—Fruit buds are produced on fruit spurs and, laterally, on 1-year-old wood. Terminal buds of shoots and vigorous spurs are usually leaf buds. Where terminal growth is less than 7 to 8 inches, nearly all lateral buds on terminal shoots are fruit buds. This wood becomes bare after fruiting. Where terminal shoots are grown to 12 inches or more, some of the lateral buds will be leaf buds from which spurs will develop. Trees with a good spur system are more productive, and fruit buds are more winter hardy on spurs

Fig. 32.—Young Montmorency cherry before pruning. Light thinning-out pruning will keep tree growing well all over.

than on laterals. It is important, therefore, to keep annual growth vigorous, so that a productive fruit spur system will be maintained.

Pruning at Planting.—Sturdy 1-year-old trees, 4 to 5 feet high, or 2-year-old branched trees, 4 to 6 feet, with diameter of ⅝ inch or more, are preferred for planting either in the fall or very early spring. Where whips are planted, head at about 24 inches and begin selection of scaffolds the second year. Where branched 2-year-olds are planted, select the leader and about three well spaced laterals, each one leaving the trunk at a wide angle, with the lowest scaffold about 15 inches above the ground on the southwest. Remove other branches.

It is preferable with cherries not to cut back the branches left to form the head, as heading-back cuts stunt branch growth.

Subsequent Training and Pruning.—The modified leader system of training is preferred to secure well spaced scaffolds. About five or six scaffolds, distributed over 3 or 4 feet of trunk above the lowest branch, develops a strong framework. The leader is then modified by cutting to an outward lateral. It is important in training cherries, not to allow one scaffold to originate from the trunk directly above another. Also, see that no two scaffold limbs originate on the trunk at the same height. Development of the leader and branches above

Fig. 33.—Same tree as in Fig. 32. A few branches which shaded lower wood were removed. All fruiting branches and spurs now receive ample sunlight and strong terminal growths are encouraged.

is choked if opposite scaffolds, or two scaffolds close together on same side, are permitted to grow.

As trees become dense, an increasing amount of thinning-out pruning is necessary to keep tops and outsides open, and to prevent inside and lower fruiting wood from dying. Keep the tree growing all over. Annual terminal growth of 12 to 15 inches of plump wood is associated with good fruit production and development of strong spurs on 2-year and older wood (Figs. 32, 33).

Many branches develop at odd angles and cross the tree. Such limbs seriously shade lower wood and should be pruned out before damage occurs.

Occasional cutting back of upright wood to outward laterals is necessary on the main branches.

A common fault in sour cherry orchards is to start the tree with a whorl of three or more branches trained to an open head. Such trees are short lived, for the head splits as the branches crowd each other (see Fig. 35).

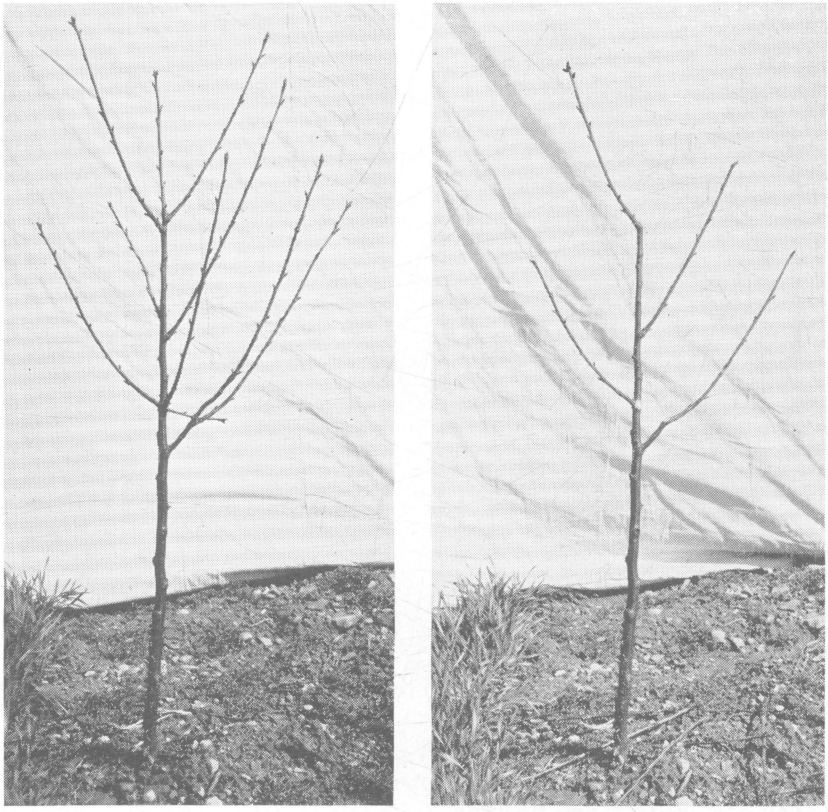

Fig. 34.—One-year sour cherry before and after pruning at planting time. Modified leader has been established. Three wide-angled branches have been left well spaced around the leader. It may be possible in later prunings to eliminate one or more of these and use branches starting higher on the trunk for wide scaffold spacing. (*Courtesy Ohio Agl. Exp. Station*).

PRUNING THE SWEET CHERRY

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Trees budded on Mazzard stock are preferred to those propagated on Mahaleb. Sturdy 1-year-old whips, 4 to 5 feet, or 2-year-olds of 5 to 7 feet and diameter of ¾ inch or more are recommended. Early spring planting is preferred, with freshly dug dormant trees; but mature trees, dug in late fall, may be planted then. Trees are often damaged in nursery storage houses over winter. Plant carefully and firm the soil well about the roots. Keep from

drying out until well started, as sweet cherry trees are difficult to transplant. Liquid wax preparations to cover bark are now on the market and tree tops dipped or sprayed to cover exposed bark above ground start best.

The modified leader system of training is followed as advised for the apple, with special attention to keep the leader and upper branches from being choked by opposite or close scaffolds.

Use thinning-out cuts or cutting to laterals, as heading-back cuts stunt branch growth and divert growth into the limbs not headed back.

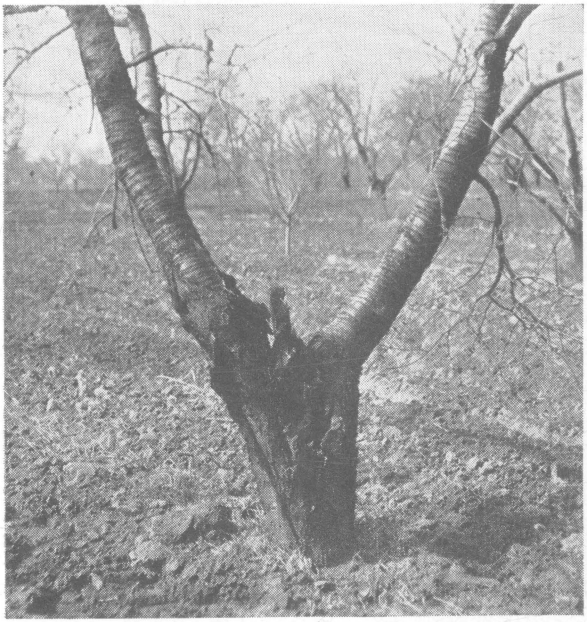

Fig. 35.—Montmorency cherry which was started with a whorl of five branches at the same height and trained to the open center system. As branches increased in diameter, crowding developed, which split the head apart and ruined the tree. Modified leader training corrects this common fault.

Three or four lateral scaffolds with 8 inches or more vertical distance between limbs, in addition to the leader which is modified into an outward limb, will make a very desirable framework for sweet cherry trees. Special attention to avoid narrow crotches in selecting scaffolds is urged. Wide scaffold crotches develop a strong head and reduce hazards from winter injury to the body of the tree.

PRUNING THE PLUM

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There are several species of plums. Those best adapted to Ohio are the European plums and prunes (*Prunus domestica*) and the Damsons (*Prunus insititia*). The Japanese plums (*Prunus salicina*) frequently lose crops by spring frosts, and the native plums, while very hardy, lack size, firmness of flesh, and market style. They are seldom planted in Ohio.

The European plums, such as Archduke, Grand Duke, Italian Prune, German Prune, Bradshaw, Imperial Epineuse, and Stanley are best pruned and trained to the modified leader as advised for apples. Scaffolds can be placed closer than with apples; about 6 inches vertical spacing is satisfactory. Lighter pruning may be followed with these and also with the Damson plums such as French and Shropshire. As the trees reach heavy bearing and growth

slackens on terminals and fruiting spurs, the amount of pruning should be increased, with detail pruning throughout the tree and enough thinning-out pruning to keep up desirable growth over the lower branches (see Fig. 36). Open pruning allows most efficient thinning, harvesting, and spraying of the fruit for control of brown rot.

The Japanese plums such as Abundance, Burbank, and Climax are naturally very spreading growers. A low open head as recommended for the peach is, therefore, preferred for Japanese plums. Considerable thinning-out pruning, especially of slender branches, is necessary. Some heading back to laterals is needed to keep a stocky, open framework. As the trees get older, shoot and spur growth slacken, and rather heavy pruning of the type suggested for bearing peach trees is advisable, as the fruiting habit of peach and Japanese plum is rather similar.

Considerable fruiting occurs laterally on 1-year wood and from vigorous spurs on older wood. By maintaining good terminal growth, the development of strong fruit spurs on 2-year and older wood is encouraged, thus increasing the productive capacity of the tree.

Fig. 36.—Stanley prune, well trained to the modified leader system. Strong scaffolds are widely spaced about the trunk.

PRUNING THE APRICOT

Apricots are only grown as novelties and for limited home use in Ohio, as the tree is not hardy, and the early habit of blossoming makes spring frost a serious hazard. A protected, well-drained site, such as just southeast of a building, is essential.

One-year-old trees, 3 to 5 feet in height and ½ inch or more in diameter, are preferred for planting in early spring.

Prune and train to open-bowl type tree as recommended for the peach. Long, slender branches need heading back to laterals. Keep trees open with considerable thinning-out pruning, as fruit spurs are rather short lived and must be frequently renewed from rather vigorous terminals. It is recommended that pruning be done in early spring to reduce hazard of winter injury.

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PRUNING THE NECTARINE

The nectarine is highly prized as a dessert fruit, and is worthy of further testing for home use and limited local market on sites where peaches are grown successfully. The tree and fruiting habits are similar to the peach, and the recommendations for pruning peaches may be followed with nectarines.

Early spring pruning is recommended for the nectarine, as this tree is quite tender and should not be pruned until after severe winter weather is over.

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PRUNING THE QUINCE

Two-year-old trees, 4 to 5 feet high, with diameter of ½ inch or more, are suggested for planting.

The fruit is borne terminally on small shoots that arise from terminal or lateral buds of the previous year's growth. For this reason, cuts should be of a thinning-out type to keep trees reasonably open. As blight is serious in Ohio on the quince, trees should be grown rather slowly in sod, as recommended for the pear. Pruning should be very light, as advised for the pear, and blight cankers handled as suggested on page 7.

Quinces are planted only for home use and limited local market, as the ravages of oriental moth prevent successful commercial culture. Since spraying is not effective in controlling oriental moth, it is suggested that soon after fruits set, enough quinces be bagged to provide for home requirements. Secure bag tightly around fruiting shoot to prevent infestation, and leave quince in bag until picked.

A natural habit of growth is desirable. Wood is tough and does not demand a particular type of training. Pruning can be done at any convenient time while trees are dormant.

PRUNING SMALL FRUITS

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PRUNING THE GRAPE

Grape bunches are borne on shoots which arise from buds on 1-year-old wood, called canes. Vines should be pruned annually to train the trunk and arms so that the minimum amount of old wood supports the desirable type and distribution of canes. Renewal spurs (see Figs. 37 and 41) are left near the base of fruiting canes to permit renewal with a similar size and type of cane for fruiting the following year.

The best time to prune is from the middle of February until the buds begin to swell. Canes will bleed if they are cut after the sap starts to run (while buds are swelling), which is annoying to the worker but is not serious. If possible, the pruning should be completed in February. The vines should not be allowed to go without annual pruning. The amount of pruning is adjusted

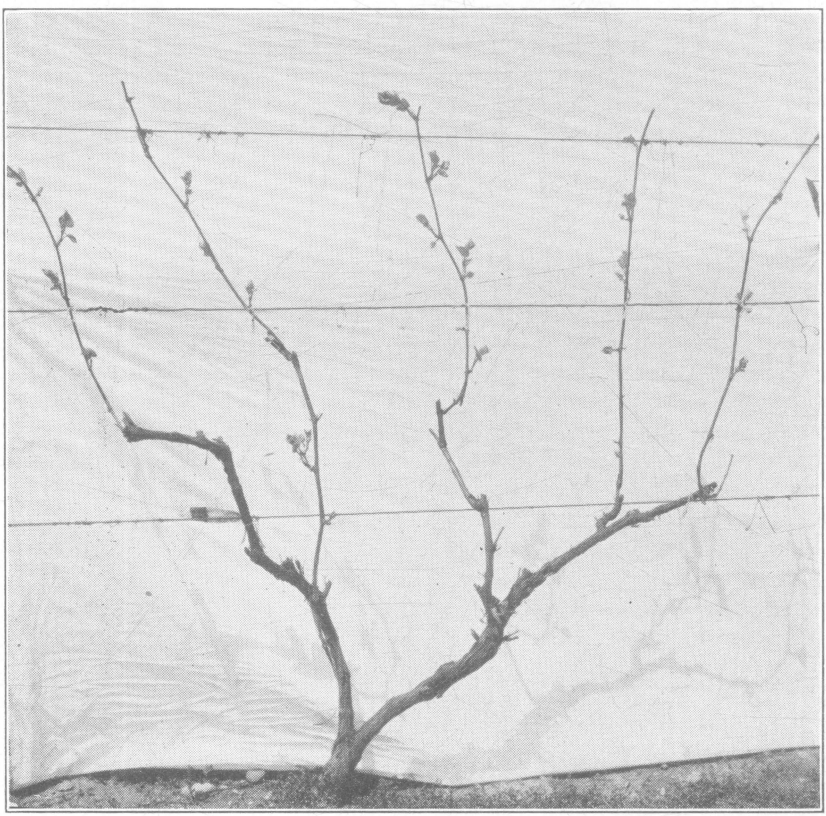

Fig. 37.—Fan system for pruning grapes. Most common system in Ohio. Note renewal spurs provided near base of each fruiting cane.

to the vigor of the vine. Fewer canes and buds are left on young or weak vines. If too much bud-carrying wood is left after pruning, the bunches may be small and scraggly, while too heavy pruning reduces yields and promotes excessive wood growth.

No pruning is needed during the growing season, as grapes do not require direct sunlight to color. Full development of healthy leaves provides the best bunches and quality in the berries.

Shoots growing away from desirable positions can be tied to the trellis or arbor during the summer as necessary.

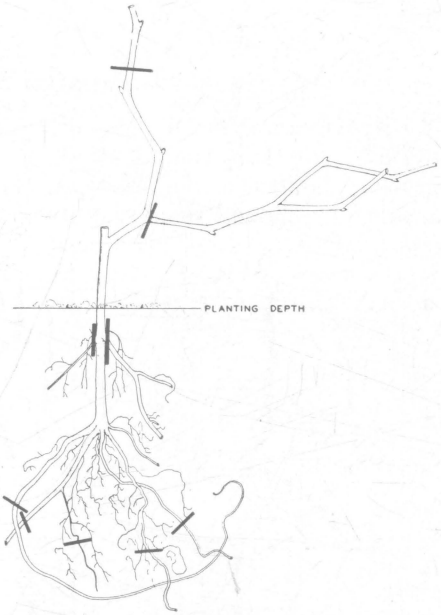

Fig. 38.—Grape plants from the nursery are pruned back to two buds. The roots and top are pruned as indicated by the black marks.

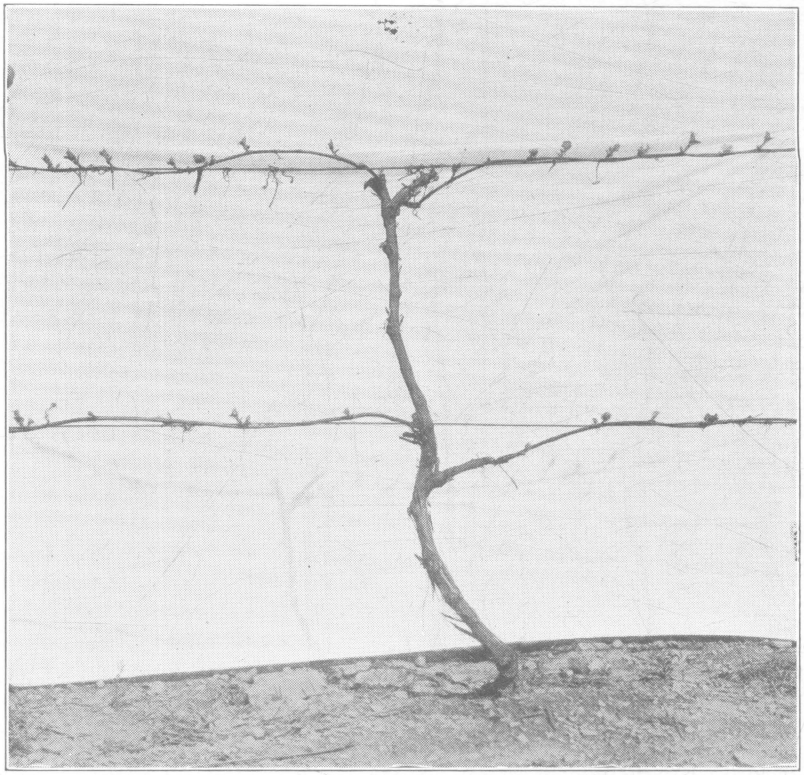

Fig. 39.—The single stem 4-cane Kniffin system. No summer tying of shoots is required.

Pruning Young Vines

The Extra or No. 1 grade of 1-year grape plants are the most economical to buy in the long run. They should have made good but not excessive top growth, and have a well developed root system. As a general rule, weak plants are undesirable and should be discarded.

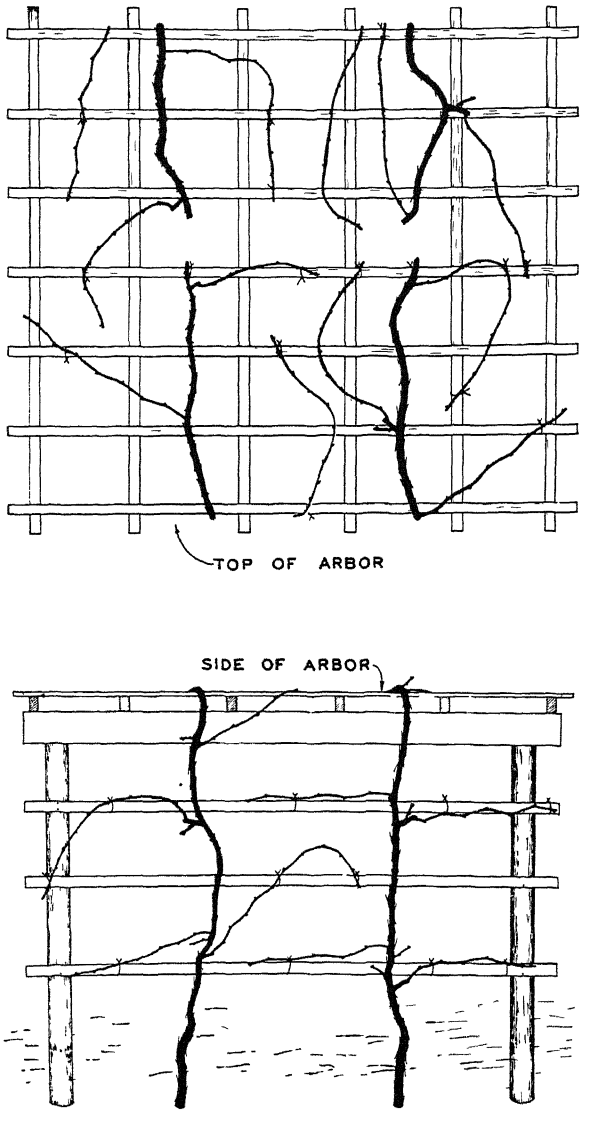

Fig. 40.—The Kniffin plan of pruning is suggested for arbors. The amount of fruiting wood (canes) and the respective renewal spurs at their base are shown after pruning. More canes are left than for trellis pruning since shade is a factor here.

First Year. — After planting, prune off all but the strongest cane, which is cut back to two buds (see Fig. 38).

Second Year. — Remove all but the best single cane. If trained on a trellis, leave the cane, if it is vigorous, long enough to reach the first wire or crosspiece of the trellis. If the best single cane is weak, cut it back to two buds as for the first year.

Where the single-stem, four-cane Kniffin system is used (see Fig. 39), which is best for Concord, Niagara, and vigorous growing varieties, train the second year to develop a straight vertical trunk. Tie the cane to a stake if the trellis wires are not up. The lower wire is usually 30 to 36 inches above the ground and the upper wire 2 feet above the lower wire. In later years, fruiting canes are tied, two at each wire level, extending to right and left of the trunk. Renewal spurs are left on short arm or trunk near base of each cane.

For the fan and modified fan system of training (see Fig. 37), the lower wire is usually 2 feet above the ground to which the trunk or each of the Y-arms are tied. Two other wires are placed above at 18 inches to 2 feet apart, to which fruiting canes are tied in an oblique pattern in later years.

Third Year.—This year the vine, if vigorous, can carry about 25 buds after pruning. For the fan system, two canes can be carried obliquely from lower to top wires. For Kniffin system, four shorter canes can be used, two at each wire level extending horizontally in opposite directions from trunk. These short canes become the arms from which fruiting canes are selected for each wire level in later years.

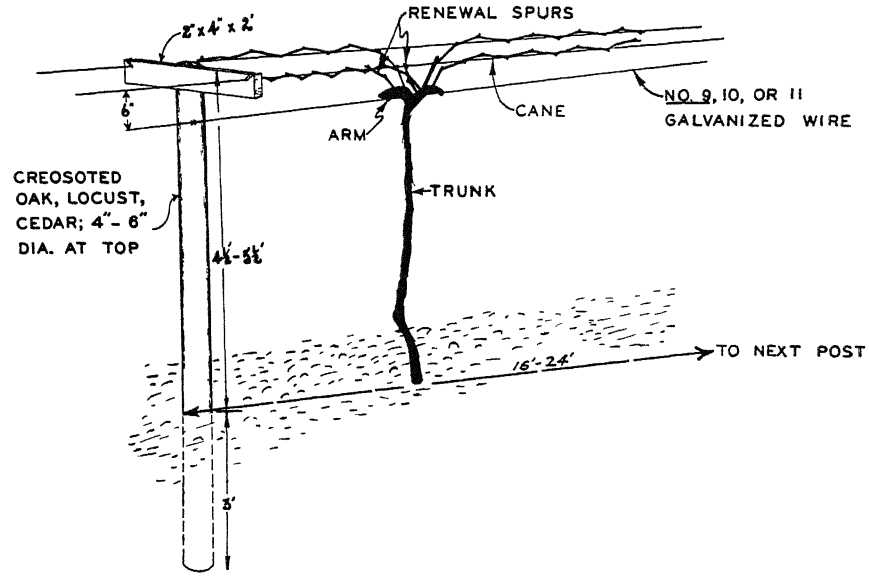

Fig. 41.—The above system for training grapes (similar to Munson system) is convenient for backyard plantings. Grapes are easy to spray, cultivate, and pick. It is convenient to pass under trellis from row to row.

Pruning Mature Vines

Select fruiting canes of plump, medium-sized wood which is carrying good buds. With Concord, canes which measure about ¼ inch in diameter between the fifth and sixth buds have been most productive. Canes with eight to ten buds after pruning are the most desirable length. These should arise as near the trunk of the vine as possible. For a *renewal* spur, select a cane arising near the base of the cane left for fruiting and cut it back to one or two buds. The spur will this year provide a cane in this location for fruiting the following year. There should be a renewal spur for each fruiting cane. Remove all surplus wood, leaving only fruiting canes and spurs. Then tie to trellis or arbor with jute twine or small size wire, using a loose tie.

Prune each vine according to its age and vigor. Mature, vigorous Concord vines may carry 40 buds or more after pruning in good vineyards, while with

weaker vines, half this number of buds may result in better fruiting. On arbors where shade is important, more old wood must be left to distribute the canes over the arbor and more fruiting canes with fewer buds to the cane are often necessary properly to distribute the fruiting capacity of the vine (see Fig. 40).

The system of trellising shown in Fig. 41 is well adapted to home vineyards, as one can easily go from row to row under trellis to work with individual vines.

Pruning Neglected Vines

Where pruning has been neglected for a year or more with mature vines, they become very rangy, with too much old wood and best fruiting wood a long distance from trunk or base of vine. Remove as much old wood as can be spared, then cut back the trunk and arms as far as possible to a point just ahead of four or five reasonably desirable canes for fruiting. After 2 or 3 years of renewal pruning, the neglected vines can be brought back to a fairly manageable pattern. If neglected vines are dehorned (cut back to large stubs with little or no young wood), there are no canes left for fruiting and it will take a year or two to get such vines producing again. It is usually best to prune neglected vines to a pattern approaching some modification of the fan system.

* * *

PRUNING THE BRAMBLES

The brambles consist of raspberries, blackberries, and dewberries. The fruit is borne on canes which grow one year, fruit the next, and die shortly after. The pruning consists of (1) summer pinching of tips of new canes, (2) removal of old canes shortly after they have fruited in summer, and (3) shortening the canes and branches in early spring while dormant.

Summer Pinching

If no wire trellis or supports are used, summer pinching of the new shoots of black and purple raspberries is generally practiced by the commercial growers in Ohio (see (Fig. 42). This consists of removing with shears or gloved fingers the top 3 or 4 inches of the new shoots when they have attained the height of 18 to 24 inches for black raspberries and 18 to 30 inches for purple raspberries. This checks terminal growth and causes several branches to develop, and results in a low, stocky plant. Such a plant withstands high winds, eliminates the need for a trellis, and facilitates harvesting the next year. It is necessary to go through the planting two or three times before and during harvest to top properly the vigorous shoots as they appear.

Summer pinching of the ends of the blackberry shoots of upright growing varieties as Eldorado is ordinarily done when the plants are about 24 to 30 inches high.

Red raspberries are not summer pruned (see Fig. 43). If tops are cut back, weak laterals are produced which are not desirable, and canes are more likely

ties such as Snyder, Eldorado, and Mersereau. On the other hand, the Early Harvest and Lawton blackberries bear their fruit near the base of the laterals and farther down on the canes.

Some varieties of blackberries are semi-prostrate in growing habit. The Brainerd, Evergreen, and Himalaya varieties are examples. The Lucretia dewberry is definitely a trailing bramble and usually trained to 7½-foot stakes which are sunk in the ground about 2½ feet. The plants are usually set in check rows, 5 by 5 feet. When the crop is harvested, the old canes are removed and the patch is cultivated in one direction until the new canes seriously interfere. Cultivation is then discontinued and the canes allowed to grow at will over the ground. The following March, seven or eight of the strongest canes are tied to the stake and cut off to about the height of 5 feet.

Fig. 45.—The photograph on the left is a Red Lake currant before pruning; on the right, after pruning. The tall growth has been cut back. Low horizontal branches and most of the wood older than 3 years has been eliminated. One-year wood has been thinned to three or four vigorous canes.

The Youngberry and Boysenberry are vigorous trailing brambles and are usually trained to a two- or three-wire vertical trellis, as shown in Fig. 44. During the March pruning, individual canes are left about 5 to 6 feet long and tied to the wires. The new canes which arise at the ground surface in spring are allowed to trail along the ground in the direction of the row. These are usually covered with 2 inches of soil or 4 inches of straw in November for winter protection, then uncovered in the spring and tied to the wires. As soon as the canes have fruited, they may be cut off close to the ground, removed and burned. These brambles are very thorny and while pruning and arranging on trellis wear high boots, heavy trousers and coat such as a hunting outfit, and leather gloves.

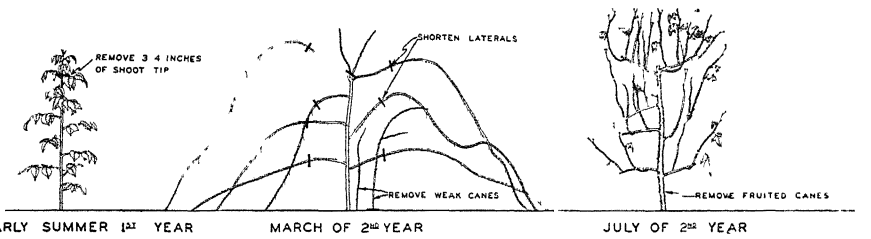

Fig. 42.—Shoots of the black and purple raspberry arise from the roots early in the growing season. When they attain proper height (see text) they should be summer pinched to induce vigorous laterals which are shortened the following March. Bearing canes are removed after harvest.

to winter-kill. Summer pinching back of red raspberry shoots also tends to reduce yields without sufficient improvement in size of berries.

Removal of Fruited Canes

It is best to remove the old canes of brambles soon after the crop is harvested. They should be removed close to the ground. A pair of long-handled lopping shears or a bramble hook are convenient tools for this purpose. Elimination of the old canes, among other advantages, gives more room, nutrients, and water to the developing shoots which will bear the crop the following year.

Dormant or Spring Pruning

The best time for dormant pruning is in March, after danger of winter freezing is past and before the buds begin to swell.

The red raspberries require only light cutting back of the tips to prevent the canes from later becoming top-heavy and bending to the ground with fruit. Although the number of berries is reduced by this pruning, the size of the

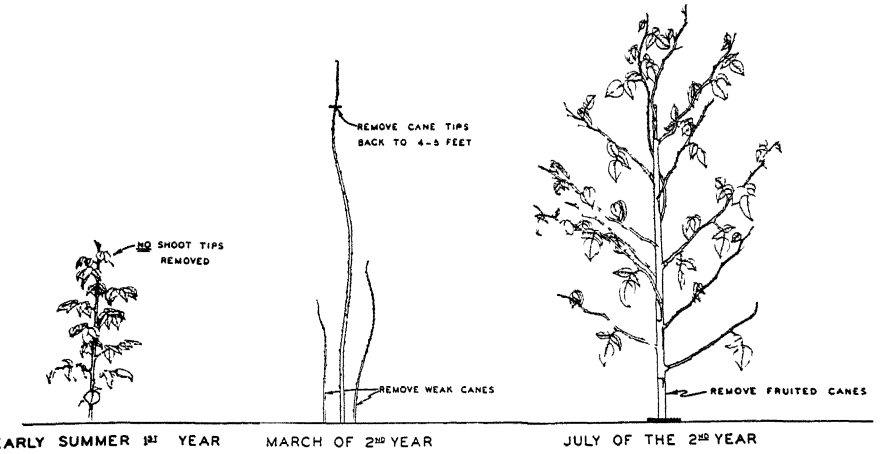

Fig. 43.—Red raspberry shoots from the roots require no summer tipping; few, if any, laterals are formed. In March of the next year the weak canes are removed, and the tips of the remaining canes cut back. After harvest canes which have borne are removed and burned.

individual berries is increased and, thus, the yield remains about the same. The small spindly canes should be pruned out of the hedge row, leaving the larger canes from 6 to 10 inches apart. If the hill system of growing red raspberries is used, about 7 or 8 strong canes per hill are left. The narrow 12-inch hedge row system of growing is preferred to the 24 to 30-inch hedge row.

In case of the black and purple raspberries, which have been summer pinched, it is necessary to prune back the laterals rather severely. For black raspberries, the size and quality of the fruit is improved by leaving the stronger laterals carrying from 8 to 12 buds on branches 6 to 8 inches long after pruning.

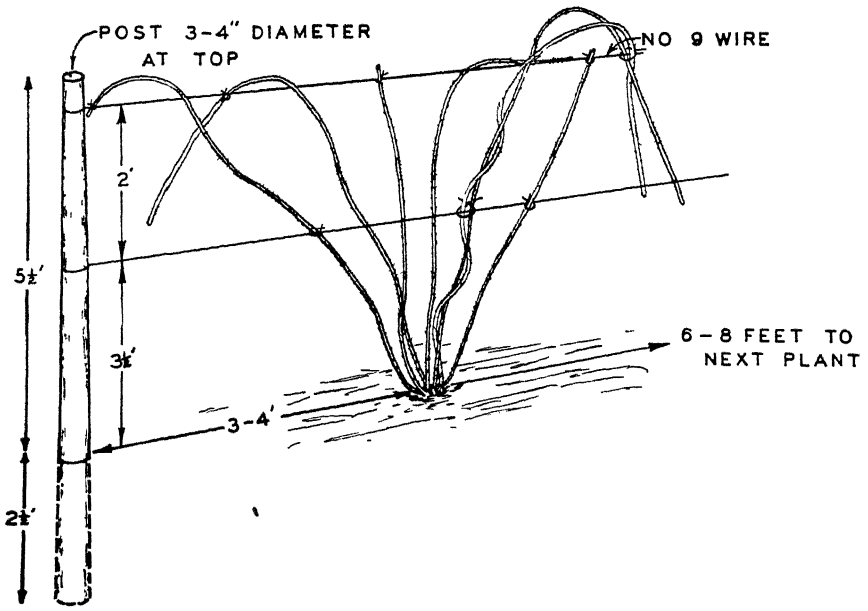

Fig. 44.—A two-wire trellis is useful for training the trailing type blackberries, and the Boysenberry and Youngberry. The trellis should be established before the beginning of the second year.

Weaker laterals may be cut shorter; very vigorous laterals may be left somewhat longer.

The laterals of purple raspberries can carry more buds than black raspberries and are pruned back to 10 to 14 inches, depending upon the vigor. Small spindly laterals should be removed entirely. The yield may be reduced if fewer than five laterals are left per cane. Do not remove canes over ½ inch in diameter at the ground level, as thick canes are most productive. Remove any surplus of canes smaller than ½ inch in diameter.

The laterals of blackberries which have been summer pinched are relatively vigorous and should be left about 18 inches in length. With blackberries, it is sometimes best to wait until the blossoms appear before the laterals are cut back. Some varieties tend to bear fruit far out on the laterals, and such a practice prevents cutting away too much of the crop. This is particularly true of varie-

PRUNING BLUEBERRIES

Blueberries may be pruned any time after the leaves have fallen during the dormant season. Since the fruit is borne on wood of the previous season's growth, it is desirable to provide necessary nutrients by fertilization, and adequate water by irritation or mulch in order to induce a good supply of annual vigorous wood. Under such conditions, larger berries of higher quality can be obtained by judicious pruning.

Little or no pruning is necessary for the first three years. The type of pruning at the end of this period depends upon the character of the growth. Some varieties are of the erect growing type, such as June, Concord, and Rubel. It is necessary to do more thinning out in the center of the bush for these varieties. However, in case of the spreading type, such as Cabot and Pioneer, the lower branches which tend to drag the ground should be removed.

The shoots which develop after the middle of the growing season are usually weak, with relatively few fruit buds. They should be removed, leaving only the vigorous growth. Some varieties, as Cabot and Pioneer, require relatively more heading back and thinning out at pruning time to thin the crop. About three to six fruit buds per shoot are left on the 2- and 3-year branches. Varieties such as Concord and Rubel require little heading back of shoots.

* * *

PRUNING CURRANTS AND GOOSEBERRIES

The fruit of the gooseberry and currant is borne on 1-year wood and 1-year spurs on older wood. Pruning consists essentially of removing branches after they have borne fruit for 2 years. Late winter or early spring pruning is recommended. Two- and 3-year wood are the most productive. In case of 1-year-old red and white currant bushes, the small weaker shoots should be removed, leaving about eight strong shoots. At the end of the second year, four or five 2-year-old and three or four 1-year-old canes should be left. After pruning the 3-year-old bush, three or four canes each of 3-, 2-, and 1-year-old wood are left. With older bushes, canes 4 years or more old should be removed as rapidly as possible. Pruning is a renewal practice to keep bush producing mostly on vigorous 2- and 3-year-old canes.

Some varieties of currants tend to grow more upright than others. These should be thinned by removal of the central shoots (see Fig. 45). In case of varieties which have a spreading type of growth, the outer and lower canes generally should be removed. If these canes are allowed to remain, they become laden with fruit, droop to the ground, interfere with cultivation, and fruit becomes dirty. If growth is relatively weak in spite of judicious pruning, the use of 10 to 20 tons of stable manure per acre per year is recommended. Larger quantities of stable or poultry manure may be applied more safely to gooseberry plantations than to currants. Commercial nitrogen fertilizer, such as sulphate of ammonia, applied at the rate of 250 pounds per acre, or about ¼ pound per bush is also effective in securing desirable growth.

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